Report of The Cyclone Review Committee

May 1984

Volume I

Government of India
Department of Science & Technology
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THE CYCLONE REVIEW COMMITTEE

PREFACE

The cyclone Review Committee was constituted on March 10, 1979 by the Government of India on the advice of the National Committee on Science & Technology. The report of the Committee took a long time to complete. It is now ready and is being submitted hereby to the Government of India for its consideration. The areas of Cyclone Monitoring and Cyclone Warning System in India as they exist today have been reviewed in Chapter 2. In this Chapter will be found also suggestions for a National Cyclone Code, a Cyclone Emergency Action Plan and a Community Preparedness Plan against Cyclones for the coastal States. The recommendations are collected together for ready reference in Chapter 3. The recommendations are in these Groups:

Group A: These are mainly for the consideration of the India Meteorological Department for the Cyclone Monitoring/Cyclone Warning Systems (Recommendations CRC/1 - CRC/107).

Group B: These are mainly for the consideration of the Government of India and the coastal State Governments with respect to

B.1 : The National Cyclone Code and the Cyclone Emergency Action Plan (Recommendations CRC/108-231)

B.2 : The Community Preparedness Plan against cyclones (Recommendations CRC/232-309).

Group C: These are concerned with Research and Training in matters connected to Cyclones (Recommendations CRC/310-317).

The highlights of the recommendations can be briefly stated. There exists already a very elaborate Cyclone Monitoring System in the country which has recently been greatly strengthened by the addition to the Systems of Surveillance by Cyclone Warning Radars, orbiting meteorological Satellites of USA and the Indian Geostationary INSAT Satellite System. The Committee considered that Satellite Monitoring of Cyclones is quite effective but it felt the necessity of supplementing the information with other monitoring techniques like radar. The Committee felt that direct probing of the Cyclone by aircraft is a vital component of Cyclone Monitoring. As will be seen in the review of the National hurricane Operation Plan of USA, aircraft probing though very expensive is very safe today provided the supportive infrastructure is good. This technique is the most informative among the various techniques generally used. Thus aircraft probing of Cyclones should be arranged in the Bay of Bengal to start with as the number of Cyclones there is larger than over the Arabian Sea. The Committee has suggested the constitution of an Apex Cyclone Committee to look into all aspects of the cyclone problem. It has suggested that this Committee should be of the nature of a Standing Committee. The Committee has pointed out the need for a telecommunication system immune to cyclones and it welcomed the INSAT Disaster Warnining System which is about to be added to the Cyclone Warning System.

There exists a complex Cyclone Warning System in the country, but since the system is not subject to periodic mock tests its effectiveness can only be judged during a cyclone emergency when chances of system failure to a certain degree can not be ruled out. The suggestions for a National Cyclone Code and Cyclone Emergency Action Plan for coastal States are outcome of a sharpening of similar plan formulated by the Andhra Pradesh Government based on the recommendations of Cyclone Distress Mitigation Committee (CDMC) appointed by the Government of India in 1970. Important items in this connection are the suggestions of the committee to constitute Coastal Development Authorities in the coastal States and the formations of the State/District Cyclone Committees. The Committee found the existence of much greater awareness of the Cyclone problems in the States of Andhra Pradesh and Tamilnadu than in other coastal States. These States have Cyclone Emergency Action Plan and the measures they have taken in the matter of Community Preparedness against Cyclones are reflected in the large programmes they have undertaken for the construction of Cyclone Shelters mostly with assistance from abroad. Much remains to be done in the other cyclone prone coastal States particularly Orissa and West Bengal, both of which appointed CDMCs in 1972 and 1974 respectively. The Committee also stressed the need to establish a Building Code for cyclone prone areas and various legislative measures needed for cyclone problems as part of the National Cyclone Code. In Chapter 4 some technical discussions have been given to scientific aspects of tropical cyclones. In chapter 5 some disastrous Indian cyclones have been reviewed to examine how the existing systems worked. It is hoped that the review made by experts achieved a measure dispassionate analysis and there is no attempt to apportion blame for any failure.

The report contains eight chapters:

Vol.1 :

1.	Chapter 1:	Formation of the Cyclone Review Committee by the Government of India
2.	Chapter 2:	Report of the Cyclone Review Committee
3.	Chapter 3:	The recommendations of the Cyclone Review Committee

Vol.2 :

1.	Chapter 4:	General informations about Cyclones. Review of the National Hurricane Operation Plan of USA
2.	Chapter 5:	Some famous Indian Cyclones
3.	Chapter 6:	Deliberations of the Cyclone Review Committee
4.	Chapter 7:	Recommendations of earlier Committees
5.	Chapter 8:	Miscellaneous

It is a matter of great regret that Prof. R. Ramanadham, member of the Committee, passed away in 1982 before the report could be submitted. Prof. Ramanadham was however present at the last meeting of the Committee and made many valuable contributions.

The Committee thanks the officers of the IMD: Dr. P.S. Pant, then Deputy Director General, Shri G.R. Gupta, Director NHAC - Delhi, Shri G.S. Manal, Director,IMD, Delhi, Dr. N.S. Bhaskar Rao, Regional Director of RMC - Madras, Shri T.S.S. Anjaneyalu, Dy. Director General (Meteorology) RMC - Calcutta, Dr. U.V. Gopal Rao, Director, Satellite Meteorology Division Delhi, Dr. A.K. Mukherji, Dy. Director General (Meteorology), Pune, and S/Shri D.K. Mishra, K. Chatterjee, Directors, IMD, Delhi, Shri S. Raghavan, Director, Cyclone Warning Radar, Madras and others for all the invaluable assistance given ungrudgingly. The Committee also thanks Prof. S. Dhawan, Secretary, Department of Space for his very kind cooperation and the officers of ISRO: Prof. E.V. Chytnis, Dr. T.A. Hariharan and others of the Space Application Centre (SAC), Ahmedabad for providing readily the informations about ISRO's contributions to the Cyclone problem. Thanks of the Committee are also due to Shri K.S. Chandrasekharan, then Special Relief Commissioner to the Government of Orissa, S/Shri V.P. Saxena and R. Lalwani, Directors (MR), P & T Department, Shri H.S. Jolly, Additional Chief Engineer and Shri V.N. Vaidyanathan, Director, Engineering Headquarters, AIR, S/Shri C.P. Joshi, Director and S.S. Kale, Additional Director, Police Wireless, Ministry of Home Affairs, Shri B.S. Mathur, Chief Engineer, Ministry of Shipping and Transport and Dr. S. Balakrishnan, Department of Agriculture for providing various information and to members of different Departments of the Government of India and the State Governments and various agencies who participated in the meetings of the CRC from time to time. The committee thanks the authorities of the Saha Institute of Nuclear Physics for free use of its facilities and for bearing the major part of the expenses to prepare this report. Finally, the Committee wishes to record its thanks to Mr. William Barney, Federal Coordinator for meteorological Services and Supporting Research of USA for providing a copy of the National Hurricane Operation Plan of USA (FCM - P12 - 1983) and permission to use it/reproduce from it and to Mr. James W. Hali, Assistant Federal Coordinator for Army and Air Force Affairs / Office of Meteorological Services and Supporting Research for a copy of NOAA Technical Memorandum NESS 45.

It is hoped that the Government of India, the Coastal State Governments and the various agencies/departments like the India Meteorological Department the Posts & Telegraph Department, All India Radio, etc. would find the recommendations useful and implement them in the 7th Plan for Cyclone Disaster Prevention.

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(Shri S.K. Das) — Director General of Meteorology, Indian Meteorological Department

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6.	APMitra (Dr.A.P. Mitra)	Director National Physical Laboratory
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8.	PKoteswaran (Dr. P. Koteswaran)	Ex-Director General (Observatories), India Meteorological Department
9.	DRakshit (Dr. D.K. Rakshit)	Member-Secretary, Principal Scientific Officer Department of Science & Technology

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CHAPTER 1

FORMATION OF THE CYCLONE REVIEW COMMITTEE BY THE GOVERNMENT OF INDIA

1.0 THE CYCLONE PROBLEM :

Every year the east and west coasts of India are visited by cyclones, some of which have proved to be particularly devastative in terms of loss of life and cattle and destruction of property. In recent years the cyclone which has been remembered for its fury and devastations in the 1977 Andhra Pradesh Cyclone of 19th-20th November which is believed to have caused death of 8500 people and loss of about 230,000 cattle heads and about 344,000 other live stocks. The loss to public utilities in monetary terms caused by this cyclone was in the region of Rs.171.6 crores.

1.1 THE CYCLONE DISTRESS MITIGATION COMMITTEE (CDMC) :

The Government of India realised the magnitude of the cyclone problem and had constituted a number of committees in the past to consider various aspects of it. After two cyclones had hit the Andhra Pradesh coast in 1969 causing a death toll of 900 lives and property damage of about Rs.200 crores, the Ministry of Irrigation and Power of the Government of India in consultation with the Ministry of Tourism and Civil Aviation appointed a Committee in 1970 under the chairmanship of Dr. P. Koteswaran, the then Director General of the Indian Meteorological Department (IMD) with members drawn from the Central and State Government to look into the problems of mitigation of distress caused by cyclones. This Cyclone Distress Mitigation Committee (CDMC) published its report in May 1971*. This report was directly concerned with the consequences of cyclones for the Andhra Pradesh coast, though many of the recommendations were valid for other coastal states also.

1.2 IMPLEMENTATION OF THE RECOMMENDATIONS OF THE CDMC :

The various agencies, in particular the IMD, AIR etc. which were assigned various tasks recommended in a series of very well considered recommendations of the CDMC, took some steps to implement them in the early seventies. The coastal states besides

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* Final Report of the Cyclone Distress Mitigation Committee Andhra Pradesh : Office of the Chief Engineer (Major Irrigation) Irrigation Branch, Hyderabad 1971.

Andhra Pradesh, Orissa and West Bengal also took measures to varying degrees to extend the Cyclone Plan of the CDMC to their states; but the steps taken were rather incomplete and much was left to be done. These State Governments formed CDMCs for their own states, which also made separate recommendations[*] appropriate for their respective states. The authorities of the Tamil Nadu State who were advised by the IMD in 1974 to appoint a CDMC for the State. They examined the report of the CDMC for Andhra Pradesh and prepared action plans for cyclone fighting and post-cyclone distress mitigation measures, all of which were incorporated in its general Disaster Plan[**]. The Maharashtra Government also formed a Committee in 1974 to work out plans for implementation of the recommendation of the CDMC for its coastal area; but it is not known what is the present status of the implementation of the recommendation of this Committee (Cf paragraph 2.380 appendix 2.20). The Government of Karnataka and Kerala which does not normally experience cyclones, made no significant move in this matter. The Government of Gujarat has yet to take a decision on the formation of a CDMC for this state in spite of the fact that this state has been battered by a number of particularly devastating cyclones in the past decade.

1.3 THE COMMITTEE OF SECRETARIES (CS) AND THE EMPOWERED COMMITTEE OF SECRETARIES (ECS) :

After the 1977 November Andhra Pradesh Cyclone had caused terrible loss of life and property, the matter was discussed by a Committee of Secretaries (CS) of the Government of India to find out the status of implementation of the recommendations of the CDMC in various coastal states and to suggest remedies for any lacunae in this matter. The Committee met on 19th May 1978 and after being convinced that many important recommendations of the CDMC were not implemented fully, it made its own recommendations and inter alia decided to set up an Empowered Committee of Secretaries (ECS) under the Chairmanship of the Secretary for Agriculture and Rural Development of the Ministry of Agriculture and Irrigation of the Government of India primarily to ensure speedy implementation of those recommendations of the CDMC on which adequate actions had not been taken so far, and also to modify earlier recommendations, if necessary, in the light of subsequent experience. The ECS met twice on 9th August 1978 and

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[*] Report of the Cyclone Distress Mitigation Committee : Government of Orissa : Irrigation & Power Department, Chief Engineer Irrigation, Bhubaneswar, Orissa 1972

Report of the Cyclone Distress Mitigation Committee set up by the Government of West Bengal : Department of Relief and Welfare (Relief branch) 1974.

[**] Antidisaster Plan Tamil Nadu : Government of Tamil Nadu 1978.

29th September 1979. In these meetings it reviewed the status of implementation of the recommendations of CDMC, item by item, took executive decisions on those recommendations on which the actions taken were insufficient and made further important recommendations. At the suggestion of the ECS, a Cyclone Project (IMDCP)*was prepared by the IMD in 1978 which was presented before the ECS and discussed by it. The IMDCP contained further recommendations on the cyclone problem necessiated by the experience gained subsequent to the publication of the CDMC report.

1.4 NEED TO REVIEW THE EXISTING CYCLONE PLAN (CPL) :

It was realised that many aspects of the cyclone problem required further input of the latest developments of Science and Technology for satisfactory solution. Over the years the IMD had set up a very elaborate machinery for cyclone detection, monitoring and tracking, of which the establishment of the radar horizon round the Indian coast after 1970 formed the most important component. To this was added monitoring by meteorological satellities from 1963 onwards. The IMD had also developed a complex Cyclone Warning Dissemination System (CWDS) but it was severely handicapped by the P&T telecommunication net work existing in the country. It seemed that there was an urgent need to look into the plans for actions in all coastal states for facing cyclone emergencies and for preparing the community when they come.

1.5 APPOINTMENT OF THE CYCLONE REVIEW COMMITTEE (CRC) :

The Department of Science & Technology (DST) was interested in the cyclone problem for some time. In 1979 Prof. M.G.K. Menon, Secretary of the DST brought the cyclone problem to the notice of Dr. Atmaram, the then Chairman of National Committee of Science and Technology (NCST). Prof. Menon suggested that a Cyclone Review Committee (CRC) should be set up under the auspices of the NCST to carry out a review of all aspects of the cyclone problem for consideration of the NCST which may be placed before the Prime Minister for subsequent implementation of the recommendations of the CRC. On the advice of Dr. Atmaram a Cyclone Review Committee was formed in under the Chairmanship of Prof. A.K. Saha in March 1979.

1.6 CYCLONE REVIEW COMMITTEE :

The composition of the CRC was as follows

1. Prof. A.K. Saha Member of NCST	Chairman
2. Director General (Observatories) IMD, New Delhi	Member

* Cyclone Project : Indian Meteorological Department New Delhi 1978.

3.	Prof. R. Ramanadham Professor of Meteorology Andhra Pradesh University Waltair	Member
4.	Dr. A.P. Mitra National Physical Laboratory New Delhi	Member
5.	Deputy Director General (Forecasting) IMD, Pune	Member
6.	Shri C.R.V. Raman Project Director (Monex) New Delhi	Member
7.	Dr. D.K. Rakshit Principal Scientific Officer Department of Science & Technology New Delhi.	Member-Secretary

The Chairman of the Committee was given the power to coopt additional experts as and when considered necessary. The Chairman coopted Dr. P. Koteswaran Ex Director General of Observatories to the Committee. At various stages representatives of the following Central and State Governments were also coopted :

1. All India Radio (AIR)
2. Indian Space Research Organisation (ISRO)
3. Governments of Andhra Pradesh, Orissa, Tamil Nadu and West Bengal
4. Ministry of Communication
5. Ministry of Home Affairs
6. Ministry of Shipping & Transport

1.7 TERMS OF REFERENCE OF THE CRC :

The terms of reference of the CRC were defined as follows

1. Review of the storm warning systems existing in the country; assessment of the requirements of additional facilities and aids as used in different countries for improving the forecast accuracy.

2. Review of the telecommunication facilities existing in the country and improvement and modernisation thereof. Additional telecommunication facilities needed for improving and widening the dissemination of informations.

3. Review of the present status of community preparedness to anticipate cyclones and their impact, and review of the action plans for cyclone distress mitigation and recommend measures for improvement in these respects, where necessary.

4. Review the cyclone codes in operation in other countries.

5. To advise the Government with a comprehensive cyclone code to meet any situation caused by a cyclone.

1.8 CONTENTS OF THE REPORT OF THE CRC :

The main report of the CRC is given in Chapter 2 of this report. It is divided in a number of sections covering the following aspects and items

I. Organisation for formulation, implementation and periodic review of the Cyclone Plan for India

II. Demarcation of cyclone prone areas of coastal India and consideration of terrains and seasons

III. Cyclone detection, observation and tracking methods and facilities in India

IV. The Cyclone Warning System (CWS) in India

V. Suggestions for formulation of a National Cyclone Code (NCC) for India and Cyclone Emergency Action Plans (CEAPs) for the coastal States

VI. Suggestions for a Community Preparedness Plan against Cyclone (CPPC) threats and hazards for coastal communities in India

VII. Cyclone Research and Training.

The recommendations are collected and serially numbered in Chapter 3 for ready reference. In Chapter 4 some general

informations are given about cyclones and their forecasting and a review of the National Hurricane Operation Plan of US.
A review has been made in Chapter 5 of some important features of some particularly devastating cyclones that appeared in the past on the Indian coasts with a special case study of the 1977 November Andhra Pradesh Cyclone. The agenda, minutes of the different meetings of the CRC and a list of documents circulated among the members appear in Chapter 6. Chapter 7 collects the recommendations of the earlier cyclone Committees. Chapter 8 contains a collections of some miscellaneous matters connected with the report.

CHAPTER 2

REPORT OF THE CYCLONE REVIEW COMMITTEE

2.0 ARRANGEMENT OF THE RECOMMENDATIONS :

The Committee makes the following recommendations for a Cyclone Plan (CPL) which contains a Cyclone Code (CC) and a Community Preparedness Plan against Cyclones (CPPC) for this country. The recommendations are arranged in a number of sections as listed in paragraph 1.8.

2.1 SOME DEVASTATING INDIAN CYCLONES AND THE EXPERIENCE GAINED THEREFROM :

Cyclones cause destruction by very strong winds which may reach velocities over 200 km/hour and storm surges that very often accompany them which may reach heights of 5-6m above the normal sea level. The highest wind velocity recorded for an Indian cyclone is 226 km/hr (1942 October Midnapore Cyclone), the lowest pressure fall recorded is 919.7 mb (1885 September False Point Cyclone) and the highest cyclone storm surge recorded is 22 ft above mean sea level (1885 September False Point Cyclone) However cyclones with higher wind speeds and storm surges have been known to have struck the coast lines of the Indian subcontinent at points which do not lie within the present boundaries of India. Thus the 1876 October Backergunge (now in Bangladesh) Cyclone had caused storm surges of height 12m (total sea level elevation) causing deaths of about a quarter million persons by drowning and epidemics. It is only very recently that it has become possible with the progress of instrumentations to measure the various parameters associated with a cyclone accurately. Storm surges are responsible for 90% loss of life and property. The 1970 November Bangladesh Cyclone caused an estimated casuality of 200000 in Bhola islands and the coastal districts no doubt because of the absence of high lands in the deltaic regions of the estuaries of that country where people could seek shelter. Similarly in the districts lying in the mouth of the Krishna River, the 1977 November Andhra Pradesh Cyclone caused about 8000 deaths of humans and a loss of about 230,000 cattle heads and 244,000 goats and other live stocks. Storm surges cause almost total destruction to the mud houses and other light structures lying in the low lying areas for these are simply dissolved and washed away. The storm surge can advance on a broad front over the coast and rush in on occasions to a depth of 25 km inland. The storm surge associated with the 1864 October contai Cyclone flooded the whole of the low lying grounds in the neighbourhood of the Hoogly river as far as Acra in Midnapore and the lower reaches of the Roopnarayan river to above Koila Ghat sweeping everything before it. The estimated loss of life by drowning for this cyclone was about 50000. If the storm surge finds the mouth of a river then it may rush in as a high bore gathering energy as it moves forward. In the wake of the inundation, epidemics follow causing often larger loss of life, if relief and rehabilitation can not be properly arranged. In the 1864 October Contai Cyclone the loss of life from post cyclone epidemic was estimated to be about 25000-30000 persons. Cyclonic storms cause extensive damage of agricultural products and in particular to the standing crops. In the 1977 Andhra Pradesh Cyclone of 19th-20th November, the area of cropped land affected was about 36.04 lakhs acres. As the flood water comes from the sea, the agriculture lands may have to stand for long time under saline water which may be disastrous for the land, needing expensive remedial measures. In the 1970 October Orissa cyclone 10000 people died and innumerable live stock perished in the storm surge in the Mahanadi estuary. Extensive areas of farm lands were rendered saline. The damages caused by the high winds of cyclones are considerable. Major damage is caused to light structured houses and even to pucca buildings if care is not taken to reinforce them specially against cyclones. Great damage is done to the ecology and environment by the uprooting of trees and blocking of drainage and sewerage systems. In the 1964 December Rameswaram Cyclone the city of Danushkodi had all its houses raized to the ground. The storm surge destroyed the Pamban bridge connecting the Mandapam to the Rameswaram islands. A passenger train that left the Rameswaram Rail Station at midnight was washed away and all its 120 passengers drowned. It is remarkable that such a severe cyclone occured in a region which was believed to be relatively free from cyclones. Thus the loss of property caused by cyclones can be considerable - for a moderate cyclone the loss may be to the tune of Rs.10 crores whereas for a severe cyclone the loss may rise to magnitudes in the region of Rs.200 crores. The 1977 November Andhra Pradesh Cyclone yields many important points for caution for the authorities in charge of cyclone management. This particular cyclone was closely monitored by satellite and radar and was well classified, and a fairly accurate idea of its parameters was obtained. But the Madras Cyclone Warning Radar (CWR) which was the only radar station monitoring it from the coast, unfortunately underestimated its intensity when it was near the landfall point almost on periphery of the receiving range of the radar. There was no overlapping radar covering the landfall point at that time. Overlapping coverage by a CWR at Masulipatnam, close to Chiralla, the landfall point was provided for in the 1969 Cyclone Plan of the IMD. Unfortunately due to various delays in the implementation of this CWR there was none at Masulipatnam in 1977. Madras CWR unfortunately did not correct for peripheral attenuation of the radar imagery of the cyclone, which was downgraded until it was too late. As a result the Andhra Pradesh State Government had hardly any warning and very little time to prepare to evacuate people. There was a paralysing feeling of helplessness among the government officials who felt that it was impossible to remove lakhs of people in the districts at the mouth of Krishna river in the time available and finally they could do almost nothing. Normally the cyclone may last 24 hours after its landfalls and in this period also it is very destructive. On land cyclones lose energy rapidly and subsides. There are occasions however when a cyclone is known to track back to the sea where it takes once again its nourishment of energy before it launches back towards land. This happened in the 1978 West Bengal depression which also points to another important aspect. The degree of inundation caused by storm surges would depend on the state of the coast also the amount of water already standing on it, the water levels in the hydrostorage dams near the coast etc.. In this storm all these factors combined to produce wide spread submergence which reached upto Calcutta which was under deep water for quite some time. It is not very easy to predict at a long time interval the precise location of the landfall of a cyclone, for tracks of cyclone are very often very erratic. Only when the cyclone is a few hours before the landfall can a fair idea be made of the landfall point, and even that only if the cyclone does not suddenly change direction. Generally for a 24 hour prediction the error of the landfall may be as much as 200 km, which fact emphasises the need of constant monitoring of a cyclone as soon as it comes within the range of detection. Finally, there is one aspect of cyclone which plagues the smooth functioning of Cyclone Warning System (CWS), which is that the Telecommunication Systems (TCSs) on which the CWS has been heavily dependent so far, being land based, very often snap under the stresses of cyclones at times when they are needed most. During the 1981 West Bengal Cyclone the Area Cyclone Warning Centre (ACWC) at Calcutta was to all intents and purposes cut off and isolated from the groups and people it was required to warn during the regime of that cyclone. Because of such failures of the normal TCSs, the CDMC had emphasised the role of broadcasts by the All India Radio round the clock to warn the public and various groups of warnees. Ever since 1971 AIR has been broadcasting cyclone warning which has considerably reduced the number of deaths caused by cyclones. Some famous Indian Cyclones will be reviewed in Chapter 5.

2.2 CYCLONE MONITORING AND WARNING SYSTEMS (CMS/CWS) :

Whereas it is an indisputable fact that cyclones cause extensive havoc in terms of loss of life and property, it must be remembered that with the great advances of Science and Technology, it is no longer necessary today to stand helpless when faced with their fury. There are many other natural disasters that have to be faced in India - tornadoes, flash floods, dam bursts, earthquakes, droughts and famines etc.. Some of these are difficult to anticipate sufficiently well in advance. In the case of cyclones, however, the radar and satellite surveillance now makes it possible to keep a continuous watch on the entire life period of a cyclone. The CWR provides the most accurate fixes of the eye of the cyclone and keeping them under continuous observation from distances in the range of 400 km from the coast. The various parameters of a particular cyclone may now be estimated by help of modern techniques with some degree of precision though it is still not possible to predict its track. Thus the cyclone analyst may work out a fair idea of the potential for havoc of a particular cyclone and make intelligent guesses of the exact location of its landfall and the area of accompanying storm surge. Sufficient advance warning is therefore now possible and preparations can be made to meet the cyclone at its landfall with the accompanying storm surge. With a well designed coastal management machinery it should be possible today to reduce the loss of life by advance evacuation and also to reduce the loss of property to a considerable degree. In the 1979 May Andhra Pradesh Cyclone which was of the severe type, the State Government evacuated the entire coastal belt and not a single death occured there. However about 700 people died in the inland taluks due to breaches of tank embankments. Recent experiences bring out the fact that while the cyclones can today be very closely monitored and cyclone warnings can be fairly rapidly disseminated among the warnees before the TCs break down under their fury, the State Governments have yet to evolve effective disaster plans with Cyclone Codes incorporated into them.

2.3 EARLIER COMMITTEES ON CYCLONES :

The country must therefore have a comprehensive Cyclone Plan to enable the community and the Governments at the Centre and the coastal states to have early detection and monitoring systems for cyclones, to give warnings sufficiently in advance to enable the authorities to put into operation the emergency measures laid down in the Cyclone Code which is essentially an work manual for cyclone emergency, including the measures for relief and rehabilitation of the affected people. In paragraphs 1.1 to 1.3 a review was made of the work done by CDMC, CS and ECS. Reference has also been made to IMDCP submitted by the IMD to the ECS. The steps taken by various coastal states to form their own CDMCs has also been reviewed in paragraph 1.2.

2.4 WORK DONE BY VARIOUS AGENCIES TO IMPLEMENT THE RECOMMENDATIONS OF THE CDMC :

The Committee appreciates the valuable work done by IMD, AIR and other organisations of the Central and the State Governments to extend the facilities for cyclone observations and warnings in the country since the publication in 1971 of the report of the CDMC.

2.5 WORLD CYCLONE PROJECT :

After the 1970 November Bangla Desh Cyclone killed 200000 people, the World Meteorological Organisation (WMO) appointed a panel of International Experts to draw up a World Cyclone Project. The various Committees formed to do this work were chaired by Dr. P. Koteswaran. The report was published in 1972 (Report of the WMO Panel of Experts on Tropical Cyclones).

2.6 INTERNATIONAL COOPERATION ON THE CYCLONE PROBLEM* :

Many of the cyclones seen in the Bay of Bengal are really the residues of typhoons which have circled the Malayan Peninsula and have entered the Bay to receive fresh nourishment of energy and thus are resusciated. This points to the importance of international cooperation on the cyclone problem. On the Warning aspect the most important Warning Centre is the Joint Typhoon Warning Centre (JTWC) at Guam in the Phillipines. But there appears to be difficulties in receiving informations from this centre for India as JTWC is under the control of the Defence Department of the Government of USA. There are many areas of cooperation with other countries in matters relating to cyclones. The Typhoon Committee was established in 1968 as an inter governmental body under the joint sponsorship of the World Meteorological Organisation (WMO) and Economic and Social Commission for Asia and Pacific (ESCAP) with the objective of reducing the enormous recurring damage caused by typhoons and associated storm surges. The action programme developed by the Committee has five components : (1) Meteorological, (2) Hydrological, (3) Disaster Prevention/Preparedness, (4) Training, (5) Research, Significant progress has been made with assistance from UNDP, ESCAP and WMO and other international organisations and interested developed countries. Similar regional bodies were created, in 1972 the Cyclone Panel for the Arabian Sea, the Bay of Bengal and the South West Indian Ocean and later the Hurricane Committee. A Technical Support Unit (TSU) was established in 1976 to coordinate the activities of the member countries of the Cyclone Panel : Bangla Desh, Burma, India, Pakistan, Sri Lanka and Thailand, and to assist them to implement the plans of the Cyclone Panel for the main primary components of the action plan which were the same as for the Typhoon Committee. The TSU is located at the IMD at Delhi. A technical plan was prepared by the Cyclone Panel for mitigation of cyclone disasters consisting of three components : (1) Meteorology, (2) Hydrology, (3) Disaster preparedness. There are also other programmes like the Voluntary Cooperation Programme (VCP) among the members of the WMO for mutual assistance. Under this programme India established the Radiosonde (RS) station at Colombo in 1978. It acquired the DS-714 Message Switching Computer of the Regional Telecommunication Hub (RTH) at Delhi and the LUCH equipment for the Global Telecommunication System (GTS) of the WMO under this programme. A recent development of major significance within the Typhoon Committee is the proposed Typhoon Operational Experiment (TOPEX) for which the initiative was taken at the 8th Congress of the WMO in 1979.

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* Information given by Dr. S.N. Sen Chief Technical Adviser Typhoon Committee

Council of Meteorological and Atmospheric Science (CMAS) - Notes on Agenda.

2.7 RECOMMENDATIONS OF THE EARLIER COMMITTEES AND THOSE OF THE PRESENT COMMITTEE :

The final recommendations made by the present Committee are based not only on the discussions at its various meetings on the different aspects of the cyclone problem but also on careful analysis of the recommendations of other Committees that considered these problems viz. the CDMC - Andhra Pradesh (1971), CDMC - Orissa (1972), CDMC - West Bengal (1975), the ECS (1978), those in IMDCP and the Report of the WMO Panel of Experts on Tropical Cyclones (1972). All these recommendations have been examined in the light of subsequent experience and their present status of implementation in the different coastal states. The Cyclone Plan proposed by the Committee is shown schematically in fig. 2.1. The report of the Committee is given in Chapter 2 and the recommendations are collected in Chapter 3. The recommendations of the CDMC - Andhra Pradesh and the IMDCP are collected under Chapter 7 (Paragraph 7.0 - 7.1 and 7.9 respectively. In the same Chapter is included the Cyclone Plan for a coastal area in Andhra Pradesh suggested by the CDMC (Paragraph 7.2). The recommendations of the CDMCs of Orissa and West Bengal are given also in Chapter 7 (Paragraph 7.4-7.5, 7.7-7.8).

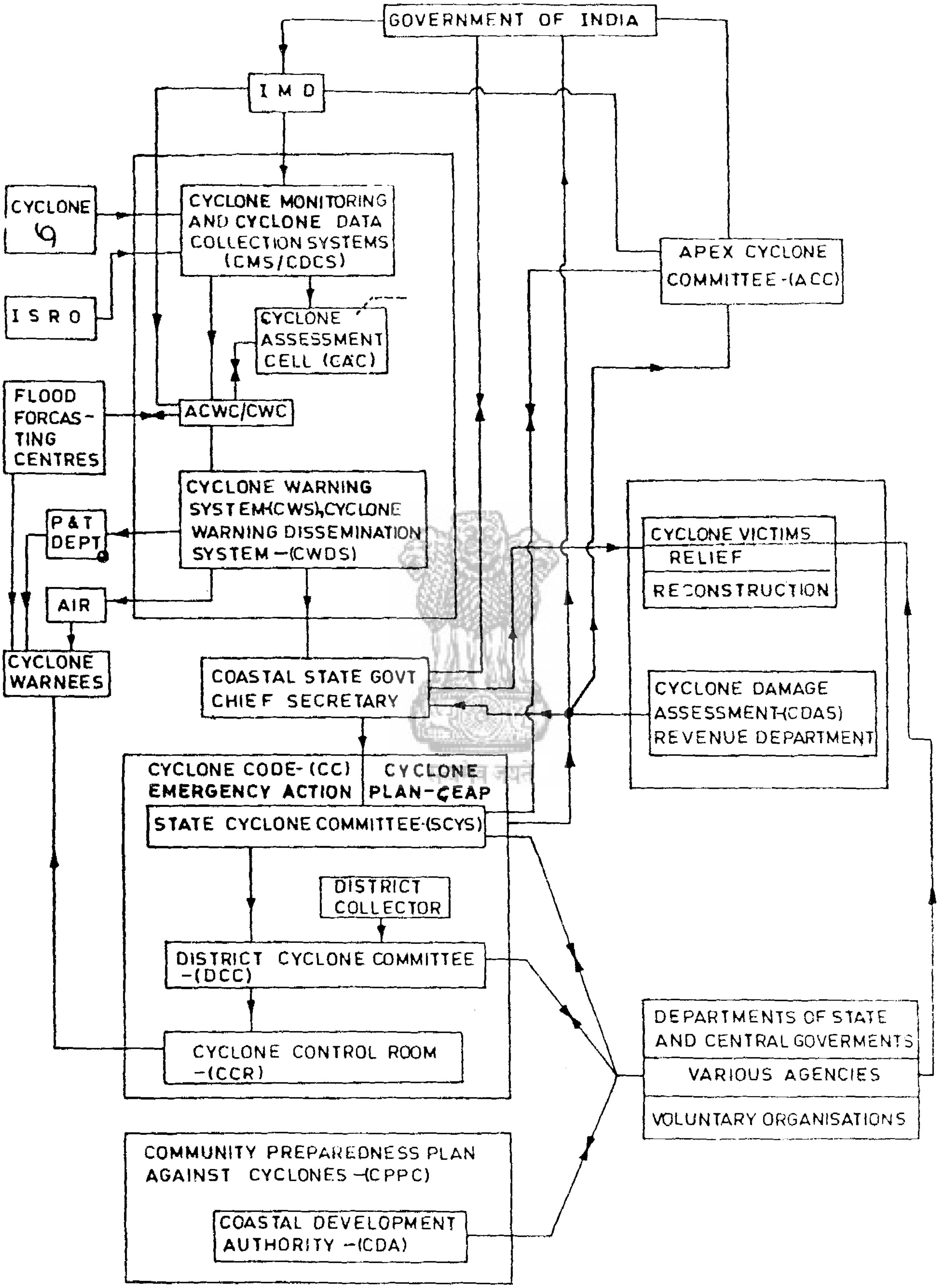
GOVERNMENT OF INDIA
I M D
CYCLONE
ISRO
CYCLONE MONITORING AND CYCLONE DATA COLLECTION SYSTEMS (CMS/CDCS)
CYCLONE ASSESSMENT CELL (CAC)
APEX CYCLONE COMMITTEE-(ACC)
FLOOD FORCASTING CENTRES
ACWC/CWC
P&T DEPT
CYCLONE WARNING SYSTEM(CWS),CYCLONE WARNING DISSEMINATION SYSTEM-(CWDS)
AIR
CYCLONE WARNEES
CYCLONE VICTIMS RELIEF
RECONSTRUCTION
COASTAL STATE GOVT CHIEF SECRETARY
CYCLONE DAMAGE ASSESSMENT-(CDAS) REVENUE DEPARTMENT
CYCLONE CODE-(CC) EMERGENCY ACTION
CYCLONE PLAN-CEAP
STATE CYCLONE COMMITTEE-(SCYS)
DISTRICT COLLECTOR
DISTRICT CYCLONE COMMITTEE -(DCC)
CYCLONE CONTROL ROOM -(CCR)
DEPARTMENTS OF STATE AND CENTRAL GOVERMENTS
VARIOUS AGENCIES
VOLUNTARY ORGANISATIONS
COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONES-(CPPC)
COASTAL DEVELOPMENT AUTHORITY-(CDA)

Fig.2.1 The Cyclone Plan (CPL) for India

2.I. ORGANISATIONS FOR THE FORMULATION, IMPLEMENTATION AND PERIODIC REVIEW OF THE CYCLONE PLAN

2.8 THE CYCLONE PLAN (CPL) :

In order to meet the dangers caused by cyclones it is necessary to have for the country a well thought out plan to cover all aspects of the associated problems. Many countries have in course of time worked out their respective plans to fight cyclones; to cite an example USA has a plan - The National Hurricane Operation Plan. This is reviewed in appendix 2.16 Chapter 4, Section IV. (paragraph 4.116-4.128). As mentioned in paragraph 2.3 the CDMC in 1971 laid down a Cyclone Plan (CPL), primarily for the Andhra Pradesh coast which was later adopted to varying degree by the other coastal states. The CPL proposed by this Committee is shown schematically in fig. 2.1.

2.9 COMPONENT PARTS OF THE CPL :

A Cyclone Plan essentially consists of two broad component parts - (1) technical aspects of cyclone monitoring and cyclone warning dissemination and an enumeration of short and long term measures to prepare the community for cyclones and (2) a Cyclone Code concretising the immediate measures to face a cyclone with prescriptions for cyclone distress mitigation procedures. The first part of (1) viz. the technical aspect is the task of the IMD which is responsible for all research and measurements of all aspects of weather in this country. The second part of (1) and the Cyclone Code are the concerns of primarily the coastal State Governments and also of the Government of India. The Committee reiterates the recommendation of CS (CS/4) about the role of the IMD in the CPL :

CRC/1 : It is the responsibility of the Indian Meteorological Department (IMD) to study in collaboration with the World Meteorological Organisation (WMO), the most modern practices being adopted in the world for predicting cyclones and storm surges and review from time to time the technical aspects of the current Cyclone Plan (CPL) of the country to incorporate these latest techniques in it to the extent necessary and possible.

2.10 THE CYCLONE CODE (CC) AND THE COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONES (CPPC) :

Regarding the remaining part of the CPL viz. the measures for Community Preparedness Plan against Cyclones (CPPC) and the Cyclone Code (CC), it is evident that these must be a part of the larger General Disaster Plans (GDP) of the coastal State

Governments. Each state has its special problems and therefore the same GDP can not apply without mutatis mutandis to all states. On the other hand the problems of cyclone distress mitigation are often similar with the distress mitigation problems for other types of disasters. Thus the problems confronted with flash floods of rivers or dam bursts caused by very heavy precipitation of rains have very much in common with those arising from storm surges. Therefore it is not advisable to have separate packets of plans for different kinds of disasters but one integrated GDP for each State. The recommendations of this Committee regarding CCs and CPPCs can be found in Section V and VI of the report. These will be in the nature of broad suggestions only.

2.11 THE APEX CYCLONE COMMITTEE (ACC) :

After the 1977 Andhra Pradesh Cyclone the CS felt the need for a body to investigate the state of implementation of the recommendation of the CDMC. As a result the ECS was constituted (paragraph 1.3). The present Committee also felt the need of a standing Apex Cyclone Committee (ACC) of the Government of India on the model of the ECS. This Committee would advise about the formulation, implementation and periodic review of the CPL, coordination of the activities of the various agencies and bodies responsible for various tasks laid down in the plan, associated financial matters and cyclone disaster assessments and mitigation of the distress. This Committee therefore modified the recommendation of CS(CS/30(3).

CRC/2 : An Apex Cyclone Committee (ACC) should be set up by the Government of India with the following terms of reference :

1. To implement the CPL in coastal India. In particular to advise the incorporation of a Cyclone Code (CC) and the Cyclone Distress Mitigation Measures (CDMMs) in the General Disaster Plans (GDPs) of the coastal states of India. For this purpose the Committee may invite social scientists, public health experts and those organisations that have experience in rescue, relief and rehabilitation works.

2. To advise the coastal states on long term measures for preparing the community against cyclones, some of which are improvements of dissemination system for cyclone warning messages (CWMs), road and transport net work, telecommunication net work, establishing embankments against storm surges, improvement of water drainage and sewerage systems, construction of cyclone shelters, protection of agricultural products,

improvement of public health systems etc. Thus the ACC would help the coastal states to prepare their Community Preparedness Plan against Cyclones (CPPCs).

3. To review periodically the CPL in the light of advance of scientific understanding of behaviour of cyclones and progress of technique of cyclone monitoring and telecommunication.

4. To assess the extent of devastation caused by each cyclone in terms of loss of life and property after the cyclone has subsided.

5. To review the extent to which it was possible to monitor and predict the behaviour of each cyclone and assess the efficiency of the Cyclone Warning System (CWS) during its regime and to advise steps to remove lacunae if any.

6. To advise the Planning Commission to provide funds for additions of technological facilities as also the long term measures to prepare the community against ravages of cyclones as suggested in the CPL.

7. To advise the Government of India on various legislative measures that may be necessary for introducing the CDMMs and various aspects of the CPL.

2.12 COMPOSITION OF THE ACC :

The Committee noted that the CS had suggested the following composition for the ECS, which performed some of the functions suggested above for the ACC.

Chairman : Secretary Agriculture and Rural Development

Members : Secretaries of Departments of (1) Civil Aviation and Tourism, (2) Communication, (3) Defence, (4) Expenditure, (5) Home Affairs, (6) Information and Broadcasting, (7) Railways, (8) Shipping and Transport, (9) Social Welfare, (10) Works and Housing.

Member Secretary : Additional Secretary (RC).

The present Committee does not wish to make any specific recommendation regarding the composition of the ACC but would like to suggest that the composition of the ECS would be a good model to follow. This Committee would like to recommend however the inclusion of two scientists as members nominated by the IMD and the DST as also a representative of the Indian Space Research Organisation (ISRO), which has deep interest in the cyclone problem. The CSIR should also have a representative on the ACC as design of buildings and low cost housings capable of resisting cyclones will become important in the CPL. Since cyclone disasters often have the character of National calamities and require long term expensive remedial measures, it is important that the Planning Commission is also represented on the ACC. A representative from the Law Ministry on the Committee is also desirable as there are many problems on which Legislative measures may become necessary. Finally, the State Cyclone Committees should also be represented on the ACC.

2.13 FUNDS :

The question of provision of funds would certainly prove to be important in a CPL. The requirement of funds comes under three broad categories :

(1) Funds for improvements of cyclone monitoring facilities and cyclone warning system. As this part of the work should be the responsibility of various organisations like the IMD, P&T, AIR etc. these organisations should provide for the necessary funds in their plans.

(2) The distress arising out of cyclones and the need for relief and rehabilitation are generated suddenly at very short notice, and these are difficult to anticipate and provide for in the annual budgetary allocations for the States. Moreover unless the reliefs are given immediately after the disaster they are to no purpose and are infructuous. This aspect viz. financial management of cyclone disasters is discussed in Section V.E of this Chapter paragraphs 2.274 to 2.283 and Appendix 2.16 paragraph 2.367.

(3) Funds for putting into effect long term measures like construction of coastal dams, cyclone shelters, improvement of roads etc.. This aspect of the CPPC will be considered in detail under Section V.E. The State Governments should make provisions in their plan allocations for all these measures which are necessary for them in not only to prepare the community for cyclones and other disaster but for many normal requirements also.

The subject of funds for relief and rehabilitation and other operations laid down in the CC and also for coast of long term measures in the CPPC as specified in (2) and (3) above will be discussed later in Section V.E of this Chapter and appendix 2.16 with respect to (1) above the Committee recommended :

oCRC/3 : The Government of India should provide adequate funds to the IMD for improvements of the Cyclone Monitoring and Warning Systems (CMS/CWS).

2.14 LEGISLATIVE MEASURES :

There are various aspects of the cyclone problem in which legislative measures may be necessary. In the opinion of this Committee, the ACC suggested above is best suited to advise on these matters. The Committee recommends :

oCRC/4 : Legislative measures should be taken to cover

1. Land use and zoning laws to restrict or prevent industrial and/or residential development in areas where cyclone risks are high e.g. low lying coastal areas exposed to storm surges. Such laws may cover taxation measures to steer development away from the cyclone prone areas (CPARs). There may also be government actions to acquire land by compulsory purchase and to alter land uses.

2. Enforcement of suitable building codes setting out minimum safety standards in areas vulnerable to cyclones.

3. Soil and plant conservation measures to guard against erosion of land caused by storm surges.

4. Engineering measures related to the management and control of rivers, roads, canals and embankments, water drainage system, protection of agricultural products and various other similar problems arising out of cyclones.

5. Public health measures and sanitation systems - against air water pollution and for waste disposals and epidemic controls etc.

6. Putting into operation the emergency measures recommended in the CC - evacuation from danger zones, emergency transport and control thereof, mitigation of distress caused by cyclones and storm surges, rescue relief and protection of life, immediate financial relief to distressed persons.

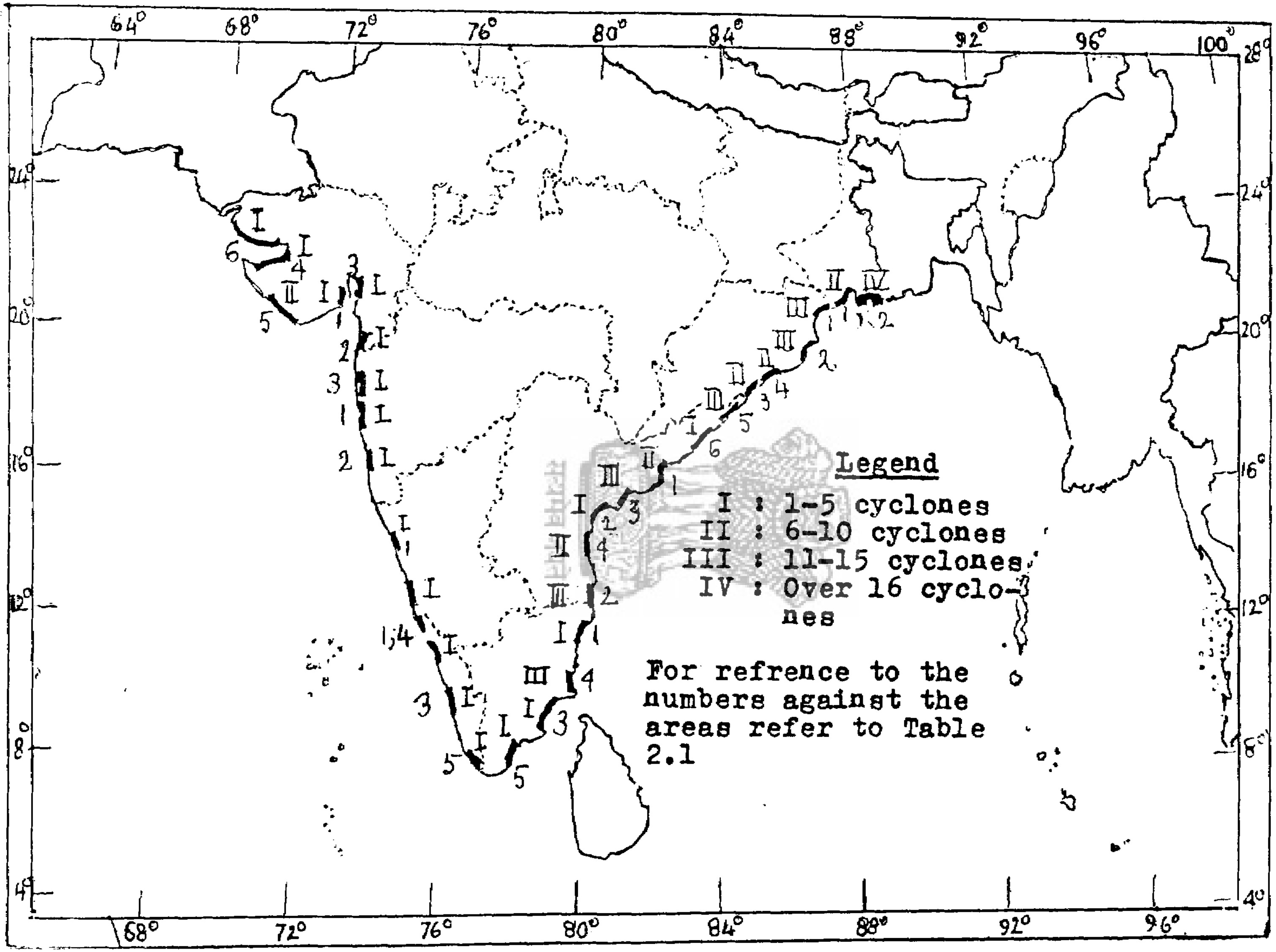

Fig.2.2 : Cyclone prone areas (CPAs) on coastal India. Cyclones recorded for period 1891-1970. References 5,6 and those under Chapter 8.1

7. Long term rehabilitation measures - restoration of buildings housings and installations, public service utilities including communications, transportation of all types, generation and distribution systems of electric power, repair of roads bridges dams dykes embankments and harbours, immediate long term loans to distressed persons.

8. Social security measures - preservation of social order, protection of properties of evacuees and prevention of crime etc.

9. Replenishment of nationally owned stockpiles such as food, seed and medicine.

10. Utilisation of international credits and gifts and aids from abroad for mitigation of distress caused by cyclones.

11. Utilisation of various funds granted by the Government of India, the concerned State Government and charitable bodies for mitigation of distress caused by cyclones.

2.II. DEMARCATION OF CYCLONE PRONE AREAS (CPARs) OF COASTAL INDIA AND CONSIDERATIONS OF TERRAINS AND SEASONS

2.15 FREQUENCY OF LANDFALL OF CYCLONES IN DIFFERENT COASTAL STATES :

Statistical evidence collected over the last hundred years have brought into prominance certain areas of coastal India as being particularly vulnerable to tropical cyclones originating in the Arabian Sea and the Bay of Bengal. Table 2.1 summarises the statistical evidence. Fig. 2.2 indicate the CPARs where cyclones are most frequent.

TABLE 2.1

FREQUENCIES OF CYCLONES LANDFALLING INTO VARIOUS DISTRICTS OF COASTAL INDIA DURING THE PERIOD 1891-1970

State	East Coast District	Frequency	State	West Coast District	Frequency
1. Andhra Pradesh	E.Godavari	7	1.Gujarat	Bhavnagar	1
	Guntur	2		Bulsar	1
	Krishna	11		Broach	1
	Nellore (including Prakasam)	10		Jamnagar	3
				Junagad	7
	Srikakulam	12		Kutch	3
	Visakhapatnam	5			
	Total	47		Total	16
2. Orissa	Balasore	13	2.Karnataka	S.Kanara	1
	Cuttack	13		Total	1
	Ganjam	6			
	Puri	7			
	Total	39	3.Kerala	Calicut	2
				Cannanore	1
				Ernaculam	1
3. Tamilnadu	S.Aroot(including Pondicherry)	4		Malapuram	1
	Chingleput	15		Trivandrum	1
	Ramanathpuram	2		Total	6
	Tanjavuram (including Puddukottai)	11	4. Maharashtra	Kolaba	3
				Ratnagiri	2
	Tirunelveli	2		Thana	1
	Total	34		Total	6
4. West Bengal	Midnapore	8			
	24 Paraganas	19			
	Total	27			
	Total	147		Total	29

* Prepared from Working Paper 2 put before the CRC by IMD. Later Dr. A.A. Ramasashtry of the IMD revised the figures as follows :

1. Andhra Pradesh : 53
2. Orissa : 33
3. West Bengal : 32

1. Karnataka : 2
2. Kerala : 5
3. Maharashtra : 10

2.16 RELATIVE FREQUENCY OF CYCLONES IN THE ARABIAN SEA AND THE BAY OF BENGAL :

Cyclones are about five times more frequent in the Bay of Bengal compared to those in the Arabian Sea. Thus the eastern coast of India needs a larger measure of surveillance and protection against cyclones than the western coast.

2.17 CYCLONE SEASONS :

It is also observed that there are well marked cyclone seasons. In the premonsoon season the period, April to June, and in the postmonsoon season the period, September to December, are the months when cyclones are most frequent and severe. The following table 2.1* brings this out clearly.

TABLE 2.2

SEASONAL FREQUENCY OF CYCLONES IN INDIA FOR THE PERIOD 1891-1982

Month	East Coast Frequency Cyclone	Severe Cyclone	Month	West Coast Cyclone	Severe Cyclone
January	4	1	January	0	0
February	0	1	February	0	0
March	2	2	March	0	0
April	11	10	April	2	4
May	15	32	May	4	15
June	32	5	June	6	12
July	33	7	July	3	0
August	27	3	August	2	0
September	23	15	September	5	3
October	40	30	October	13	12
November	40	45	November	7	22
December	22	18	December	4	2
Total	249	169	Total	46	70

The Committee recommended

oCRC/5 : In the premonsoon season the period April to June and the postmonsoon season the period September to December may be declared as Cyclone seasons when the coastal State Governments of Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal should be generally prepared for cyclones.

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* Prepared from Working Paper 3 put before the CRC by IMD and subsequently updated.

2.18 CPARs :

So far the disaster aspect is concerned it is necessary to define and declare cyclone prone areas (CPARs) of coastal India so that the State Governments may implement their CCs and CPPs in these areas to a greater degree to meet the furies of cyclones during the cyclone seasons.

2.19 PRINCIPLES FOR DEMARCATING THE CPARs :

The general principles in demarcating coastal CPARs are based on the following facts :

1. A cyclone rapidly dissipates its energy after its landfall. The devastating potential due to the storm surge sustains rarely after a distance of about 20 km from the coast, but wind damages may extend upto 100 km.

2. River mouths would make entry of storm surges easier, and the tidal bores resulting therefrom may go up to 25 km along the river course causing overflow above the river banks.

3. Hydrodams near the coast add to the disaster because of sudden accumulation of water due to heavy precipitation caused by cyclones needing some time immediate release of water which add to inundations.

4. During the monsoon the rivers are generally burdened with large amount of water. To this water is added the water brought down by rains caused by cyclones and that added by breach of tank bunds in the inland taluks in the coastal districts. Even after the cyclones weaken into depressions, heavy rains continue in the inland districts along the cyclone tracks. Thus inland districts may also be regarded to be included in the list of the CPARs.

   The actual effectiveness of these factors depend on the terrain. The same type of storm surge height may have different devastation potential at different locations depending on the nature of the terrain and its height over the sea level. The various parameters must be periodically considered by the State Governments in determining which areas in their states are particularly vulnerable to cyclones and storm surges.

2.20 DECLARATION OF CYCLONE PRONE DISTRICTS OF COASTAL INDIA :

The Committee recommends :

o/CRC/6 : Certain districts on coastal India as listed below may be declared as CPARs. Generally the CPARs may be demarkated by strips on the coast of width of about 25 km. The demarcation would depend on the topology, river systems, high lands/embankments and hydrodams near to the coast and should be done after due consideration by the coastal State Governments. Landfall records of past-cyclones reveal the following coastal districts of India as particularly vulnerable to such storms. While making the final declaration of the CPARs, the IMD and the various flood forecasting centres of the Central/State Governments/ IMD located in the concerned coastal state may be consulted.

CYCLONE PRONE DISTRICTS :

1. Andhra Pradesh : E. Godavari, Krishna, Nellore (including Prakasam), Shrikakulam
2. Orissa : Balasore, Cuttack, Ganjam, Puri
3. Tamil Nadu : Chingleput, Tanjavur
4. West Bengal : Midnapore, 24 Parganas.

The list is by no means complete and each coastal State Governments should consider which other areas in the state may be declared as CPARs.

oCRC/7 : The flood forecasting centres of the Central Water Commission/State Irrigation Department/IMD should have at their disposals topological maps of the CPARs of the coastal regions of India prepared by the State Governments with contour lines at 1m intervals to prepare storm surge risk maps (SSRMs) to use for assessment from the storm surge height forecasts in the Cyclone Warning Messages (CWMs), the possible extent of

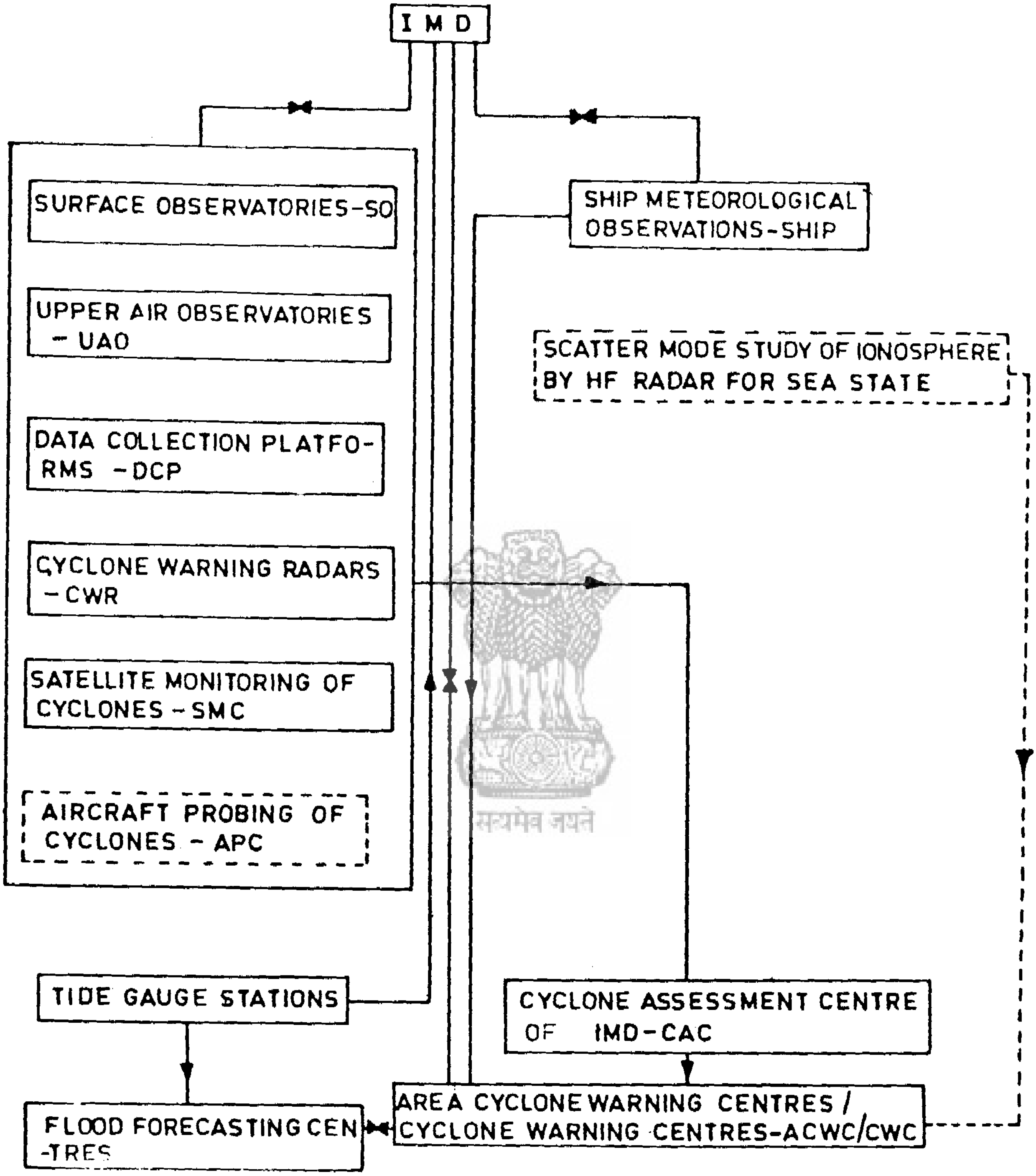
I M D
SURFACE OBSERVATORIES-SO
UPPER AIR OBSERVATORIES - UAO
DATA COLLECTION PLATFORMS -DCP
CYCLONE WARNING RADARS -CWR
SATELLITE MONITORING OF CYCLONES - SMC
AIRCRAFT PROBING OF CYCLONES - APC
SHIP METEOROLOGICAL OBSERVATIONS-SHIP
SCATTER MODE STUDY OF IONOSPHERE BY HF RADAR FOR SEA STATE
TIDE GAUGE STATIONS
CYCLONE ASSESSMENT CENTRE OF IMD-CAC
FLOOD FORECASTING CENTRES
AREA CYCLONE WARNING CENTRES / CYCLONE WARNING CENTRES-ACWC/CWC

Fig.2.3 : The Cyclone Monitoring System (CMS) in India.
References 4,38.39

of inundations, which information should be immediately available to the concerned public in the storm surge/flood forecasts and the cyclone advisories (CAs). This would enable the concerned District Cyclone Committee (DCC) to put into operation the appropriate emergency measures.

2.III. CYCLONE DETECTION, OBSERVATION AND TRACKING METHODS AND FACILITIES IN INDIA

2.21 REVIEW OF CYCLONE MONITORING FACILITIES IN INDIA :

Since the observation facilities installed at the various meteorological observatories and meteorological centres of other categories provide the main-stay of cyclone monitoring, the Committee discussed in very great detail the present status of the existing facilities.

2.22 CYCLONE PREDICTIONS :

Many aspects of cyclone storms still require proper investigations for their understanding. Thus for example it is not yet possible to predict its structure, motion or its life cycle. Thus the basis of Cyclone Warning System (CWS) still stands on the development of an efficient monitoring system to watch the evolution of a cyclone and its behaviour in course of time.

2.23 CYCLONE INDICATORS :

For the purpose of cyclone monitoring certain meteorological indicators are necessary. The Meteorologists usually choose the following as the meteorological indicators for cyclone : (1) the eye and the surrounding cloud walls, if it can be seen, (2) the characteristic cloud structure, (3) the maximum pressure fall or pressure depth (MPD), (4) the maximum wind speeds (MWS). Attempts are also made to monitor also (1) the extent of the cyclone field with mapping of pressures and winds over it and (2) the speed and direction of motion of the cyclone complex. Often more detailed structure of the cyclone is required like pressures and winds at different heights (levels) within the cyclone. A detailed discussion about these matters will be found in Chapter 4, Section III (paragraph 4.88-4.115).

2.24 CYCLONE MONITORING FACILITIES IN INDIA* :

The main observation facilities are at the various Surface Observatories (SOs), Upper Air Observatories (UAOs), sea going ships, Tide Gauge Stations (TGSs), Cyclone Warning Radars (CWRs), Automatic Picture Transmission Receiving Stations (APTRSs) for receiving pictures from orbitting Polar Orbital Satellites. Automatic Data Collection Platforms (DCPs) will be added to the monitoring systems. Recently the meteorological segment of the INSAT-1A Satellite was put into use for a short time for cyclone monitoring. The Cyclone Monitoring System (CMS) is shown schematically in fig. 2.3.

2.25 MEASUREMENT OF PARAMETERS OF A CYCLONE :

Over the cyclone field, which can extend more than 1000 of kilometers, pressure and wind data on land may be obtained from Surface Observatories (SOs) and Upper Air Observatories (UAOs) and on sea by measurements on ships and observations recorded at the DCPs. The measurements near the eye of the cyclone are not available from the land based observatories till few hours before the cyclone landfalls. When the cyclone is far out on the sea during the early period of its life, the first indication of its existence, its cloud structure and motion comes from the ship observatories and the radar/the satellite imageries. The observations are taken up by the Cyclone Warning Radars (CWRs) when the cyclone crosses into the radar horizon which is set parallel to the coast at about a distance of 400 km from it. Detailed three dimensional structure of a cyclone can be obtained only by cyclone probing aircrafts (CPAs) which are not yet available in India.

2.26 OBJECTIVES OF CYCLONE FORECASTING :

With these parameters, efforts have been made to model the evolution of cyclones with the objective to predict whether the cyclone would landfall, and if it would, the precise location of the landfall point on the coast to forecast the time of the landfall, the winds in the cyclone field in the neighbourhood of the landfall point, and the magnitude of the storm surge it might induce. The aim is to have precision in locating the landfall point at least 24 hrs. in advance in order to have sufficient time to put the CC in operation.

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* IMD Cyclone Manual : Chapter 2.

2.27 FORECAST OF MOVEMENT OF THE CENTRE OF A CYCLONE :

A number of computation techniques have been developed to forecast the motion of a cyclone :

1. Computor oriented persistence cum climatology technique with equal weightage to both. The vector error between the predicted and actual position is about 167 km for 24 hrs and 259 km for 48 hrs.

2. With the above technique a synoptic factor viz. the 24 hrs pressure tendency from coastal observations may be introduced when the cyclone is 500 km off the coast. This has limited success when the cyclone recurves parallel to the coast.

3. Combination of average tropospheric flow method with the statistical methods. This technique is based on determining the steering flow near the storm by analysis of the weighted average vector winds in a large volume surrounding the cyclone. This may give satisfactory results for the direction of cyclone motion. The method is not practicable in India because of lack of cyclone probing aircrafts (CPAs).

4. Analog method of forecasting attempts to match the past track of a cyclone with a historical track selected from the cyclone archive and introduce some modifications warranted by the current situation. It is typically the first guidance principle for forecast making.

5. Numerical forecasting by nondivergent barotropic model. This technique is based on the use of 500 mb stream lines and isotach analysis predicting the total flow over a large field. The technique is still in the investigative stage and is not yet generally applicable operationally. Aircrafts are necessary to probe the cyclone at high altitude levels to provide the basic data for this method.

6. Recently satellite imagery has also yielded a technique of determining the direction of cyclone motion. It has been observed that changes in the location of major structural features of the storm are correlated with changes in direction of motion of the cyclone eye. Major structural features appear to retain the same relative location with respect to the direction of

movement. Thus by observing the rotation of the major cloud pattern over 24 hrs by polar orbitting satellites it is possible to visualise deflections of cyclone tracks. With geosynchronous satellites constant monitoring of a cyclone is possible every half hour, and therefore deviations of the track at close time intervals can be seen.

7. Operationally the most important method of forecasting cyclone tracks is the method of radar tracking of the cyclone after it has crossed into the radar horizon. Once the cyclone is within the radar range it can be kept under continuous surveillance. Forecasts of movement and the location of the landfall point are made by extrapolation of the past track taking into consideration the acceleration/deceleration during the past few hours. The radar analyst has to take to other means when the cyclone comes to a halt for anticipating possible change of direction of motion of the system.

The cyclone track forecasting techniques have been reviewed in the paragraphs 4.54 to 4.87 of Chapter 4 Section II. With all these techniques, the error in pinpointing the landfall area can be as much as 200 km for a 24 hr. prediction. The main cause of the error of predicting landfalls are the error in predicting the direction of motion over 24 hrs. and errors in predicting the nature of the cyclone from satellite or radar imagery. Also the cyclones can be very erratic and temperamental in their motions and are known to indulge in very sudden swings. It is therefore necessary to keep a cyclone under constant vigilance after it crosses into the radar range and issue cyclone warnings over about segements of 300 km of the coast though extreme dangers of wind and storm surges may affect only a small part of it.

2.III.A CYCLONE DATA COLLECTION SYSTEMS (CDCSs)

2.III.A(1) SURFACE OBSERVATORIES (SOs)

2.28 SOs :

Surface Observatories (SOs) of the IMD are primarily concerned with observations of surface pressures, surface wind velocities, temperatures, humidities, visibilities, clouds and rainfalls. It has been observed that during severe cyclones when wind velocities exceed 140 km/hour the existing cup anemometers are either insensitive or are liable to be damaged or are blown off. Aneroid barometers were recommended for pressure measurements because they are easy to calibrate read and maintain and because they are sturdy and capable of very long service, The Committee recommends :

oCRC/8 : Since the most important parameters for assessment of cyclones are pressure falls and wind velocities, all the coastal surface observatories (SOs) of the IMD should be equipped with sturdy aneroid barometers and robust anemometers. Some selected SOs on the CPARs should be equipped with anemometers capable of measuring wind speeds upto 200 kmph. Efforts should be made by the IMD for indigenous development of such anemometers and towers for housing them capable of standing upto such winds.

2.29 TYPES OF SOs :

The SOs of the IMD are of the two types - one the regular full time departmental observatories (referred to in this report as DSOs) worked by regular departmental staff and the other type of observatories (referred to in this report as PTSOs) worked by part time workers borrowed on monthly allowances from outside organisations. At the DSOs observations are recorded* four times or more during the day. The standard hours of observations are 0230, 0530, 0830, 1130, 1430, 1730, 2030, 2330 hrs IST. At the PTSOs observations are taken** only one daily at 0830 hrs IST during noncyclonic seasons and during cyclonic seasons at 0830 and 1730 hrs IST. During a cyclone regime there are often requests for hourly observations. The experience is that the performance of the PTSOs are far from satisfactory even in normal times, and they are of very little use for data collections during the cyclone regime. Moreover during the onset of cyclones it may be very difficult for operators to approach the instruments in these observatories. The Committee therefore reiterates the recommendation in the IMDCP (IMDCP/1).

oCRC/9 : The part time SOs (PTSOs) on coastal India should be converted ultimately into departmental SOs (DSOs) and provided with distant reading equipments for measuring winds, pressures and rainfalls. Such instruments should be developed by the IMD in collaboration wherever possible with the research and technical development organisations in India. The IMD must ensure the completion of conversion of PTSOs to PSOs in 3-4 years.

CRC/10 : As the pace of conversion of PTSOs to DSOs is too slow, and as the observational net work will have to depend on the PTSOs for some time, academic organisations should be involved in the running of these PTSOs stations for better performance.

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* IMD-CP

** IMD Cyclone Manual - Chapter 2

2.30 ACCESSIBILITY TO THE SOs DURING A CYCLONE REGIME :

In view of the fact that during Cyclone regimes many of the instruments at the SOs may be inaccessible, these instruments should be gradually automatised. The Committee was aware that there are considerable logistic difficulties for routine maintenance and transmission of data from automatised SOs. The Committee recommended

CRC/11 : A few SOs at selected sites on coastal India should be automatised and made self telecasting on an experimental basis. For this purpose the IMD should develop the necessary technology in collaboration, wherever possible, with the research and technical development organisations in India.

2.31 NEED FOR R&D ON INSTRUMENTATION FOR SOs :

The Committee was informed of the proposal of the IMD to establish a Surface Instrumentation R&D laboratory at Pune. The areas of R&D work would be

1. Design/development of improved meteorological sensors for ground based observations over lands/seas.
2. Design/development of electronics and other ancillary instruments/packages for semi/full automation of meteorological data acquisition from SOs/fixed unmanned stations on lands/seas.
3. Design/development of suitable electronic equipment for receiving/quick dissemination of airport meteorological data to reach forecasting offices.

To this programme the Committee would suggest addition of the programmes of SO instrument development for cyclone monitoring needs as suggested in recommendations CRC/8,9,10,11.

2.32 DISTRIBUTION OF SOs IN COASTAL INDIA* :

The Committee also considered the density of those observatories. There are about 552 SOs in the country. About 72 of these are DSOs. The distribution of these observatories in the various coastal states are as shown in first and second coloumns of table 2.3. A list of the SOs is given in table 2.35 of the appendix 2.3. Paragraph 2.322. After the CDMC report was published a close net work of surface observatories was established for such surface measurements for cyclones. This has come to be known as the Cooperative Cyclone Reporting Network (CCRN). These later observatories are all of the PTSO type. The third and fourth coloumns of table 2.3 give the distribution of PTSOs of the CCRN already established and those that have been proposed. The names of the observatories of the CCRN are given in table 2.36 and 2.37 of the appendix 2.3(paragraph 2.323). All the observatories are shown in figures 2.41 and 2.42. The Observatories existing prior to 1978 are shown in

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* IMD Cyclone Manual : Chapter 2
IMD Standard Brief 1983.

TABLE 2.3

DISTRIBUTION OF SURFACE OBSERVATORIES (SOs) IN THE COASTAL STATES OF INDIA

	Surface observatories prior to 1978		Cooperative Cyclone reporting network		Total
	DSO	PTSO	Established	Proposed	
1.Andaman Group	1	6	-	-	7
2.Andhra Pradesh	8	4	13	25	50
3.Gujarat	8	8	-	-	16
4.Goa	2	1	-	-	3
5.Karnataka	2	3	-	-	5
6.Kerala	4	4	-	-	8
7.Laksadwip Group	2	2	-	-	4
8.Maharashtra	5	3	-	-	8
9.Orissa	5	2	16	7	30
10.Pondicherry	1	2	-	-	3
11.Tamil Nadu	7	6	-	-	13
12.West Bengal	4	4	2	6	16
Total	52	45	31	38	163

fig. 2.41. The observatories established after 1978 are shown in fig. 2.42. with those proposed. The WMO norm for SOs is 150 km between stations. A closer net work is needed for cyclone monitoring by measurement of pressure falls and wind velocities. It is observed from the above table that the IMD is making every effort to have a close net work of SOs for cyclone monitoring. The Committee however felt that the present net work of SOs is still very inadequate, particularly in West Bengal where the mouth of the delta is marked by numerous islands. The Committee therefore recommends

CRC/12 : The densities of SOs in the CPARs areas of Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal are inadequate and should be increased sufficiently to cover the needs of the CMS.

2.III.A(2) : UPPER AIR OBSERVATORIES (UAOs)

2.33 UAOs[*] :

The information about weather in the upper levels are generally obtained from the observations at the Upper Air Observatories (UAOs). There are four types of UAOs depending on the type of observation facilities. On coastal India there are twelve UAOs of type RSO/RWO which have both Radiosonde and Radiowind facilities, one UAOs of type 2(RSO) which has Radiosonde facility only, one UAOs of type 3(RWO) with Radiowind facility only, and twenty UAOs of type 4(PIBAL) with Pilot Baloon facility only. The Pilot Baloon method is essentially tracking the wind by visual sighting, and during rain and low clouds is unpractical. The Radiowind method enables wind observations in upper layers in all weathers. Upper air observations at present taken only four times daily at 0530, 1130, 1730, 2330 hrs IST. Radiosonde observations are taken usually twice daily at 0530 and 1730 hrs IST and provide informations on upper air temperatures, humidities, pressures and winds. Radiowind observations are also taken twice daily at these times. There was so far no facility to measure the parameters for the upper air on high seas which was a serious limitation in the CMS when the cyclones are located out on the sea. Recently the Government of India has acquired marine vessels for oceanic research which are to be planned to be fitted with upper air observation facilities. This will remove a long standing lacuna in the CMS.

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[*] IMD CP

2.34 NEED FOR CONVERSION OF PILOT BALOON (PIBAL) OBSERVATORIES TO MORE SOPHISTICATED TYPES OF UAOs :

It will be seen (paragraph 2.38) that the west coast is very sparsely covered by RS/RW Observatories. It is also generally true that during the onslaught of cyclones, the Pilot Baloons become useless. The Committee was informed that the IMD proposed

1. to increase the number of RSOs/RWOs in the country from 34 to 44.
2. to convert 5 PIBALOs (Pilot Baloons Observatories) to RSO/RWOs by installing multimet radars fabricated by Bharat Electronics (paragraph 2.36)
3. upgrade 10 RWOs to RSOs/RWOs, 7 have been already upgraded
4. establish regional centres for maintenance of UAO equipments. Sanction has been obtained for this proposal

The Committee reiterated the recommendation of IMDCP (IMD-CP/2)

CRC/13 : The Upper Air Observatories (UAOs) network on the west coast may be usefully strengthened by converting immediately the Pilot Baloon Observatories (PIBALOs) at Bhuj, Vereval and Ratnagirias Radiowind Observatories(RWOs)

CRC/14 : Though the UAO network on coastal India may be just adequate, it is advisable to convert, in course of time, all the coastal PIBAL Observatories to RW Observatories or to locate a few mobile RS/RW vans along the coast which can be moved into the affected areas.

2.35 FREQUENCY OF OBSERVATIONS AT THE UAOs :

The Committee recommends

CRC/15 : The frequency of recording observations should be increased to four times daily at all RS/RW observatories when they come into the cyclone field.

2.36 NEED FOR MODERNISING THE EQUIPMENTS AT THE UAOs :

Some of the UAOs are using METOX theodolites which have outlived their usefulness and can not provide accurate wind data at high levels of the atmosphere. Moreover they are incapable of giving wind information below 15° elevation. There are a number of X-band radars which can be used to find weathers and winds. These are generally installed at airports. A list of these weather radars are given in table 2.42 of appendix 2.6 paragraph 2.329. Most of them are over 20 years old and need urgent replacement. One X-band weather radar has been ordered with Bharat Electronics which makes these radars with Plan Position Indicator (PPI)/remote displays/test equipments/accessories/spares. The wind finding radars coming in greater use at the UAOs are the Multimet Radars and the WF 100-5 radar which is a sophisticated new generation radar employing advance digital techniques based on IC circuitry/ micro-processor based computers/teletypewriters and input/ output interfacer to computers. One Bharat Electronic Multimet radar has been installed in Bangalore since 1980, Four others have been ordered with the Bharat Electronic. A WF 100-5 radar acquired in the MONEX programme has been installed in Ahmedabad in 1979. The Multimet radars are capable of providing RW and taking RS observations and have facilities for automatic computation of these data. The multimets can also be used for storm warning purpose and are specially useful in jet stream areas.

CRC/16 : Some of the METOX theodolites and the weather X-band radars at the UAOs are very old and have outlived their usefulness for wind determination at high levels of the atmosphere. They should be replaced by modern wind finding radars manufactured in the country by Bharat Electronics like Multimet radars, if their performance is satisfactory. Otherwise the replacements have to be done by import.

2.37 NEED FOR R&D ON INSTRUMENTATION FOR UAO OBSERVATIONS :

The demand for accuracy and reliability of UAO observations has grown in the last few years both for low/high levels of the atmosphere. The Committee was informed of the proposal of the IMD to set up an Upper Air Instruments R&D Division at Delhi. The specific areas of R&D work would be

1. Development of upper air observational
    (1) RS systems capable of providing upper air data upto 30-35 km
    (2) Instruments and sensors for low level soundings using tethered and slow rising balloons

    (3) Specialised upper air observation systems and accessories.

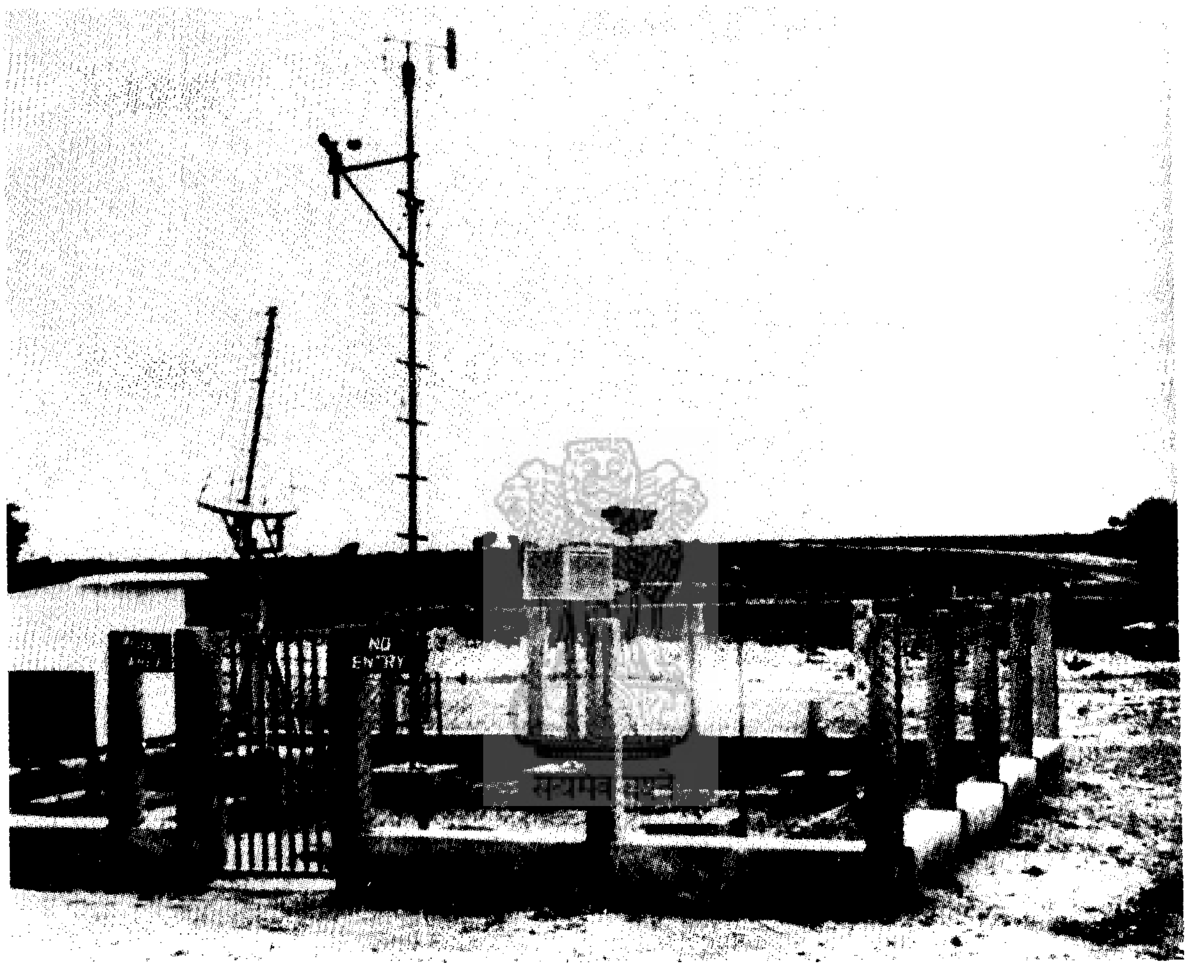
2. Development of upper air observation systems abroad ship
    (1) Optical wind finding systems
    (2) RS systems
    (3) Low level sounding systems for temperature/humidity/wind measurements
    (4) RW systems based on navigational aids
3. Design/development of electronic sensors/telemetry electronics/instrumentation for meteorological research and reconnaissance by aircrafts.
4. Development of wind finding radar interfaced with automatic data computers
5. Development of remote sensing techniques/systems for probing earth's near environment with acoustic radar/laser/other contemporary systems
6. Development of reference RS for temperature/pressure/humidity.

2.38 DISTRIBUTION OF UAOs ON COASTAL INDIA[*] :

There are 63 PIBALOs, 34 RSOs, 34 RWOs in the country. The distribution of the UAOs in the various coastal states are given in table 2.4

IMD Standard Brief 1983.

33.1



A Data Collection Platform (DCP)—on the left the small housing is for electronic parts of the DCP. The sensors are within the enclosure. The antenna is visible. Photogragh obtained by courtesy of Dr. A. K. Mukherjee of the IMD.

TABLE 2.4

DISTRIBUTION OF UPPER AIR OBSERVATORIES (UAOs) IN THE COASTAL STATES OF INDIA

State	RSS	RWS	PIBALO
1. Andaman Group	1	1	1
2. Andhra Pradesh	2	2	2
3. Gujarat	-	-	3
4. Goa	1	1	1
5. Karnataka	1	1	1
6. Kerala	2	1	2
7. Lakshadwip Group	1	2	2
8. Maharashtra	1	1	3
9. Orissa	1	1	3
10. Pondicherry	1	1	1
11. Tamil Nadu	1	1	1
12. West Bengal	1	1	1
Total	13	13	21

Legend : RSO = Radiosonde observatory,
RWO = Radiowind Observatory

PIBALO = Pilot Baloon Observatory

A list of the UAOs is given in table 2.40 of the appendix 2.4 (paragraph 2.327). These observatories are shown in fig. 2.43.

2.III.A(3) DATA COLLECTION PLATFORMS (DCPs)

2.39 DATA COLLECTION PLATFORM (DCP) PROJECT* :

As a part of the Indian National Satellites (INSAT) Meteorological Application Programme (MAP) a very important facility - the Automatic Data Collection Platform (DCP) is in course of being put into operation by the IMD. These platforms are designed to be a packet of autonomous selfoperating meteorological instruments. At specified times the DCPs would transmit the meteorological/hydrological/oceanographic data relevant to its environment to the various data collecting centres of the IMD via the INSAT. The platforms would be positioned in remote inaccessible areas like mountain tops, sea surfaces, snow field, deserts etc.. The document of the IMD proposing the DCP programme was finished in 1979 after which the work on the programme started. The first DCPs were established at Ahmedabad, Delhi and Shriharikota for the Bhaskara satellite whose transponder failed. There was no malfunctioning of the DCPs however. The first of the regular series of DCPs for the INSAT was established at Hassan at the Master Control facility. The DCP project is time bound and involves close coordination of organisations like the IMD, the P&T Department, the Department of Space and the Central Water Commission and other water management bodies.

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* Council of Meteorology and Atmospheric Science (CMAS) - Notes on Agenda

2.40 FEATURES OF THE DCPs AND THE DCP WORK PROGRAMME :

The functional components of the DCPs consist of two main components

(1) Sensors/associated electronics for collection of meteorological/hydrological/oceanographic data. The meteorological sensors have been discussed in paragraph 2.41.

(2) Data Conversion Storage and Transmission System (DCSTS) for transmission of data of the INSAT. The Committee was told that the design of the DCSTS was finalised and the selection of the contractor for manufacture of this item has also been made.

The DCPs will transmit their data on

(1) Wind speed/direction

(2) Air temperature

(3) Atmospheric pressure

(4) Relative humidity

(5) River level/flow rate/surface temperature

(6) Sea surface temperature

As a part of the INSAT Meteorological Application Programme (Paragraph 2.64, 2.71) the DCP work programme consists of

(1) Installation of 110 DCP - 100 over land, 10 over sea in remote areas

(2) Procurement of capital equipments, materials and components for fabrication/testing/installation/maintenance of DCPs from indigenous/foreign sources

(3) Fabrication of different components/subsystems

(4) To carry out R&D work on DCPs

(5) Integration/testing/repair of DCPs

(6) Periodical maintenance of DCPs including repairs/servicing at field maintenance centres.

Instrument Division Pune has been assigned the responsibility of installation/fabrication/operation/maintenance of the DCPs. It is proposed that ultimately there would be four maintenance centres at Bombay, Calcutta, Delhi and Madras with the principal maintenance centre at Pune. The duties of the maintenance centres would be : the meteorological officer

(1) will visit the locations of the DCPs for charging the batteries, preventive maintenance and calibration

(2) will attend malfunctioning DCPs

(3) ensure satisfactory functioning of the DCPs

(4) service the cards/subunits of the DCPs

2.41 METEOROLOGICAL SENSORS ABROAD THE DCPs[*] :

The Committee considered the proposal of Indian Space

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[*] Indian National Satellite System (INSAT-1), telecommunication, TV broadcasting to community receivers, meteorological earth observation and data relay : A pamphlet published by the Government of India.

Research Organisation (ISRO) for the various meteorological sensors which should be installed on the DCPs. The Committee endorsed the proposal as being useful for cyclone monitoring and recommended

CRC/17 : The DCPs should have atleast ten primary meteorological/oceanographic sensors for measuring : (1) air temperature, (2) wet bulb temperature, (3) relative humidity, (4) wind speed, (5) wind direction, (6) atmospheric pressure, (7) DCP housing temperature, (8) rainfall, (9) sunshine and (10) sea surface temperature.

2.42 DISTRIBUTION OF THE DCPs ON COASTAL INDIA :

Table 2.5 gives the distribution of the proposed DCP in the coastal states.

TABLE 2.5

PROPOSED DISTRIBUTION OF THE DATA COLLECTION PLATFORMS (DCPs) IN THE COASTAL STATES/ISLAND GROUPS OF INDIA

East Coast		West Coast	
State	Number	State	Number
1. Andaman Group	-	1. Goa	-
2. Andhra Pradesh	14	2. Gujarat	12
3. Orissa	10	3. Karnataka	6
4. Tamil Nadu	8	4. Kerala	8
5. Pondicherry	1	5. Lakshadwip	-
6. West Bengal	7	6. Maharashtra	11
Total	40	Total	37

Table 2.41 and fig. 2.44 in appendix 2.5 (paragraph 2.323) gives the proposed locations of the DCPs. The Committee noted that in the first phase of the INSAT-1 programme it is proposed to set up 100 DCPs on land and 10 DCPs over the sea. The IMD had made the proposals (IMDCP/3) at atleast 10 ships of the Voluntary

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* Information on location of DCPs provided by Dr.U.V.Gopala Rao of the IMD.

Observation Fleet (VOF) should carry DCPs on board to transmit the observations on the sea to the forecasting centres. The Committee did not endorse in view of the alternatives available today. The Committee endorsed the recommendation of the IMD in its Cyclone Project (IMDCP/10(1))

CRC/18 : After the INSAT-1 programme is satisfactorily implemented, some of the coastal SOs in the areas, where cyclone landfalls are more frequent, may be converted into automatic Data Collection Platforms (DCPs) if necessary. The collected meteorological data may then be transmitted via the INSAT system on real time to the various warning/forecasting centres and data collecting centres of the IMD : Area Cyclone Warning Centres/Cyclone Warning Centres (ACWC/CWCs) and the Regional/State Collecting Centres (RCC/SCCs).

2.III.A(4) SHIP METEOROLOGICAL DATA (SMD)

2.43 COLLECTION OF METEOROLOGICAL DATA BY SHIPS :

Traditionally much of the early informations about cyclones were obtained from sea going vessels plying over the Bay of Bengal and the Arabian Sea. At present about 274 merchant ships of Indian registry and a few foreign merchant vessels using Indian ports are used for collection of meteorological data over these sea areas. They are equipped with meteorological instruments and these constitute what is known as the Voluntary Observation Fleet (VOF). These ships are in three categories : (1) Selected ships equipped with sufficient certified meteorological instruments which transmit full weather reports in full SHIP code form; in these ships observations are entered in meteorological log books, (2) Supplementary ships equipped with limited number of certified meteorological instruments which transmit weather reports in abbreviated code forms; the observations are entered in meteorological log books, (3) Auxiliary ships which are normally not equipped with certified instruments and transmit reports in reduced code or plain language either as routine or by request in data sparse areas. There are at present 39 selected ships, 203 supplementary ships and 32 auxiliary ships. The observations abroad these ships are taken at 0530 hr, 1130 hr, 1730 hr, 2330 hr IST and transmitted by the wireless telegraphy (WT) to the coastal radio stations. The quality of ship/coastal radio station communication has not been good. The ship observations are :

(1) Pressure/temperature/humidity/winds

(2) Sea swells/sea surface temperature

After the installation of the INMARSAT (International Marine Satellite) system, it has become much easier to collect SHIP data through this system. The Committee recommended

CRC/19 : All meteorological data (SHIP) collected by the ships of the Voluntary Observation Fleet (VOF) plying in the shipping lanes of the Arabian Sea and the Bay of Bengal should be gathered through the INMARSAT system. The necessary transmitting/receiving equipments may be installed in the chosen ships of the VOF by the concerned Shipping companies. The weather data so collected should be transmitted expeditiously to the ACWC/CWCs and the RCC/SCCs.

2.44 OCEANOGRAPHIC RESEARCH VESSELS* (ORVs) :

It has already been mentioned in paragraph 2.33 that three Oceanographic Research Vessels (ORVs) are being acquired by the Ocean Science Technology Authority (OSTA) of the Government of India.** One of them, the Sagarkanya has been commissioned already. The nonmeteorological programmes of the ORVs would be inter alia : (1) oil exploration and (2) collection of biological species/marine foods. The meteorological/hydrological programmes of the ORVs are :

(1) Organise observations on upper air on the ORVs at various atmospheric levels by RS/RW techniques. The parameters to be measured are temperature/pressure/humidity/wind direction/wind speeds

(2) Make sea level observations of air temperature/pressure, wind direction/speed/sea waves/swell waves/surface temperatures

(3) Study air-sea interaction

(4) Study the general air circulation and its structure over the seas during different seasons

(5) To develop methologies for forecasting weather/state of the sea over high seas.

The observations would be round the clock. It is also proposed to establish two Marine Coastal Offices (MCO) at Madras and the other at Bombay or some other convenient places. The Committee recommended

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* CMAS - Minutes Notes on Agenda

** The recently established the department of Ocean Development has taken over the responsibility.

CRC/20 : A Maritime Meteorological Organisation should be set up in the IMD and located at some suitable centre to provide the following meteorological services : (1) Weather routing of ships, (2) Forecasting of the state of the sea, (3) Forecasting of sea surface temperature, (4) Information about layer depths, and forecasting sea subsurface temperature in the fixed layers and (5) Weather forecasting services for fishing operations. At present all these activities are carried out at various places. There is need to coordinate these activities at one place under one organisation. Apart from providing these services, this organisation should also take up research on all aspects of marine climatology and marine weather forecasting and serve as the nodal point for data collection from the Oceanographic Research Vessels (ORVs).

2.45 PORT METEOROLOGICAL LIAISON OFFICES (PMLOs) :

The Committee noted the proposal of the IMD to establish more PMLOs at the Indian ports.

2.III.A(5)-A(6) : REMOTE SENSING OF CYCLONES BY VARIOUS TECHNIQUES

2.46 REMOTE SENSING OF CYCLONES :

For advance cyclone warnings it is necessary to have methods to monitor a cyclone and its track from a large distance from it, and to estimate its parameters from these observations. These methods can be classified under the broad classes.

(1) observation of cyclones by radars

(2) observation of cyclones by satellites

These will be considered now.

2.III.A(5) : THE CYCLONE WARNING RADARS (CWRs)*

2.47 RADAR OBSERVATION OF CYCLONES IN INDIA :

Since the publication of the CDMC report, valuable achievements have been made by the IMD in establishing a radar horizon about 400 km from the Indian coast, which is parallel to almost the entire length of the east coast and covers also part of the west coast. The basic instrument in a cyclone warning radar(CWR) is a S band radar working on 10 cm wave length with a range of 400 km. Currently IMD is referring to these radars as Cyclone Detection Radars (CDRS). It is now possible to detect a cyclone as soon as it crosses into the radar horizon and travel inwards towards the Indian coast and follow its movements. This may mean very often the possiblity of warnings 24 hours in advance, provided the cyclone does not abruptly change its direction of motion, which however very often it does.

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* IMDCP

2.48 FEATURES OF A CYCLONE SEEN ON A RADARSCOPE* :

The technical aspect of radar monitoring of cyclones from radarscope imageries is described in detail in Chapter4 Section III paragraph 4.100-4.104. Here only the main features of a cyclone as seen on a radarscope will be described. A well developed cyclone can be characterised by the following well known features revealed on the radarscope :

(1) Pre hurricane squall lines which are formed at the outer periphery of well developed cyclones generally more than 500 km ahead of the eye. Since these echoes are convective in nature, they are identified by their circular structures with well defined edges. These lines are usually well arranged in spiral bands associated with the rain shield area and their orientations may be different from the main precipitation spiral bands. These are usually the first indicators of an approaching cyclone on the radarscope. The lines are generally oriented normal to the direction of propagation.

(2) Outer convective bands, sometimes two or three in number, are found in advance of the main rain shield curved generally in a spiral form, at a distance of 400 km from the eye. Only when these spirals are well organised, fitting of spiral overlays for fixing the location of the eye can be attempted.

(3) The main rain shield and precipitation spiral bands or the inner bands are the most prominent and distinguishing features of a cyclone. These are located at 200 km from the eye in the right forward sector of the cyclone with respect to the track of the eye.

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These are areas of very heavy precipitations. With reduced gain of the receiver, the spiral rain bands in the rain shield area may be detected. Close to the eye the inner bands conform to logarithmic spirals, the angle of crossing diminishing for inner bands approaching the eye.

(4) The intense eye wall surrounding the generally precipitation free eye can be a complete ring or may be partially open.

(5) The eye of the cyclone, usually 20-30 km in diameter is the central echo free area surrounded by rain band spirals. The shape of the eye may be round or elliptical, becoming irregular and less defined after rainfall. The tracking of the cyclone with a radar can be done with confidence only if the eye and the complete cyclonic circulation can be identified from the wall cloud. Very great caution is necessary if only an irregular eye or an eye wall is seen, for the identification remains uncertain. Once the radar fixes on the eye's a continuous watch should be maintained on its movement, changes in shape and spatial extent, intensification etc.

(6) If the eye is well identified and the eye wall round it could be seen, it should be possible to correlate these features with the regions of maximum wind speeds which are known to occur on the eye wall. But precise guide lines have not been laid down as the data collected on Indian cyclones with revealed eye and eye wall features and the data on maximum wind strengths are still not sufficient to establish a correlation. The radar observer keeps a watch on the eye in the radarscope for any changes on its shape, extent and the structure of the rain bands round it. Sometimes double eyes are revealed, which are beleived to occur occasionally just prior to the time of the greatest intensity of the cyclone. Decrease of both the eyes indicate deepening of the cyclone system. For Indian cyclone double eyes are rarely seen.

(7) By assessing the intensities of the radar echoes, the rainfall intensities in various sectors can be estimated and the total amount of rainfall over a particular area. Isoecho techniques are employed for this purpose computed by digital integration. The analysis can be done automatically by a Digital

Video Integrator and Processor (DVIP) analysis for any pre-selected water shed.

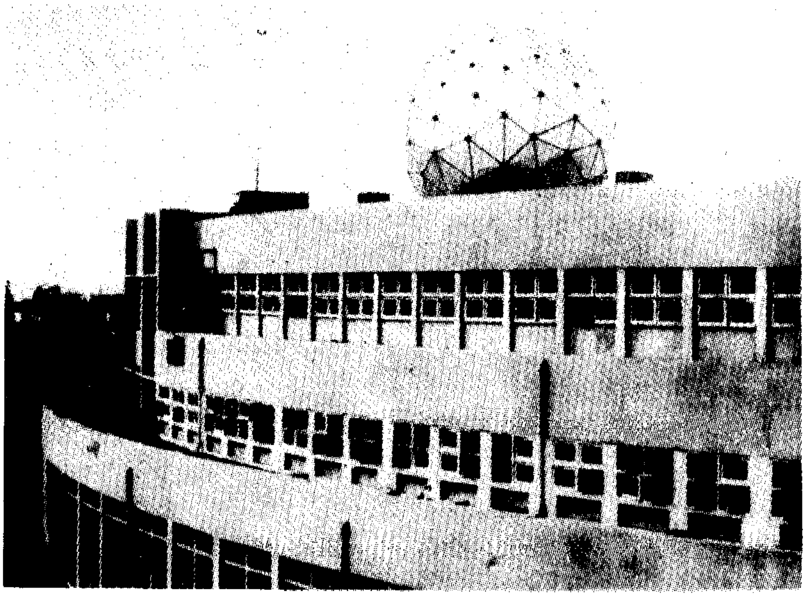
(8) Movement of the eye (centre) of the cyclone is tracked by plotting the positions measured on the Plan Position Indicator (PPI) scope at the CWR at suitable intervals of time on a large scale map of the sea and the coast. The radar track indicates short period gyrations of the cyclone and tendensies if any, to recurve or make a loop. By extrapolating the track forward basing on the informations available of its past motion, fairly accurate predictions of the landfall can be made. Rough ideas of the direction of motion can be obtained also from a sequence of pictures of the associated cloud patterns on the radarscope.

2.49 LIMITATION OF RADAR OBSERVATIONS OF CYCLONES :

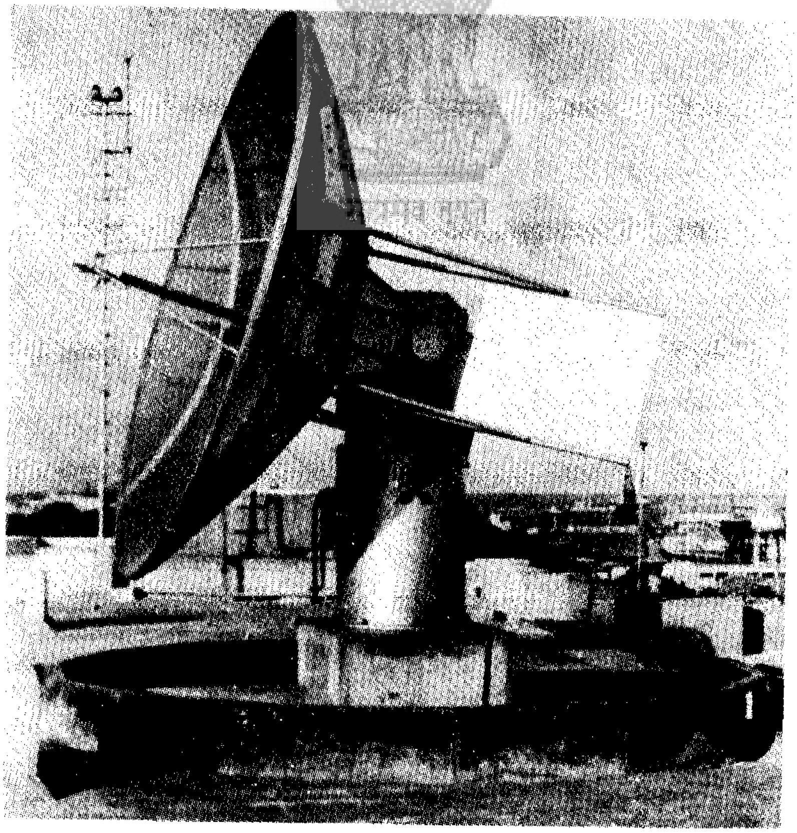
The Committee noted that the radar, though an important tool for locating and monitoring a cyclone, has limitations with regard to measurement of the important parameters for cyclone-assessments-wind strengths and the central pressure falls. USA has developed nomograms correlating these structures with maximum wind strengths and pressure falls. For satellite imageries the correlation with maximum wind and maximum pressure fall for Atlantic hurricane was achieved by Dyorak (paragraph 2.58 and Chapter 4 Section III paragraph 4.88-4.115). Radars may sometimes miss the eye of the cyclone altogether if there is heavy intervening precipitation. The S-band radar has the least attenuation caused by rain shield and is therefore preferred for cyclone watching and warning. In X-band radar the inner spiral bands block out the eye and beyond, which regions are usually seen easily on the S-band radars. Also the ranges of radar detection of cyclones are limited compared to those possible with satellite monitoring or aircraft probing. In this connection reference may be made to the detailed analysis appearing in Chapter 4 paragraph 4.100.

2.50 THE PRESENT STATUS OF THE CWRs :

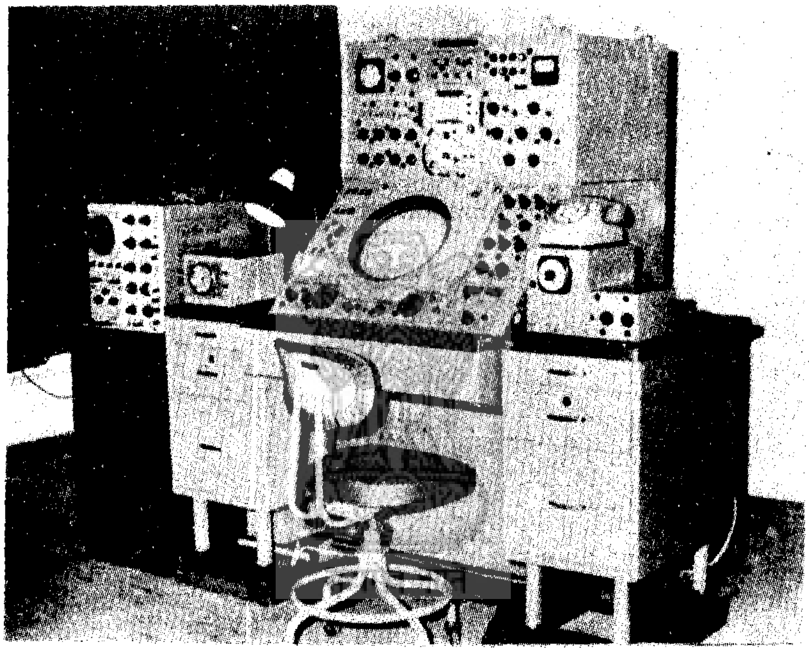
The CWRs are distributed on the Indian coast as shown in table 2.6.



Cyclone Warning Radar (CWR)—Madras. View of Radome enclosing the radar antenna. Photograph obtained by courtesy of Shri S. Raghavan of the IMD.



CWR-Madras. Closeup of radar antenna. By Courtesy of Shri S. Raghavan of the IMD.



CWR-Madras. Radar operation console and display. Photograph obtained by courtesy of S. Raghavan of the IMD.

TABLE 2.6

THE CYCLONE WARNING RADARS (CWRs) ROUND THE INDIA COAST

	Existing CWRs	Radar Type	Proposed CWRs
I. West Coast			
1. Goa	Panjim	PSS-500 (Bharat Electronics India)	
2. Gujarat	-		A suitable location on the Saurashtra coast
3. Kerala	-		
4. Maharashtra	Bombay (1975)	PSS-500 (Bharat Electronics India)	
	Total 2		
II. East Coast			
1. Andaman Group			Port Blair (approved but not yet installed) PSS 500 (Bharat Electronics) is proposed.
2. Andhra Pradesh	1. Masulipatnam (1981)	(Enterprise Electronics Corporation USA)	
	2. Visakhapatnam (1969) was replaced (1981)	IMA-118A (Japan Radio Co. Japan) replaced by another (Enterprise Electronics Corporation USA)	

	Existing CWRs	Radar Type	Proposed CWRs
3. Orissa	Paradeep(1973)	43S(Plassey Co.UK) proposed to be replaced by another(Bharat Electronic India)	
4. Pondicherry	Karaikal(1980)	PSS-500 Bharat Electronics India)	
5. Tamil Nadu	Madras(1973)	3C 32E (Mitsubishi Japan)	
6. West Bengal	Calcutta(1973)	RC 32E (Mitsubishi Japan)	
	Total 6		

Legend: Number in bracket indicates date of installation

The first CWRs were established at Delhi in 1964 and then transferred to Visakhapatnam in 1969. The radar was of the type JMA-118A from Japan. The CWRs at Bombay, Calcutta, Madras, Paradeep were installed in 1973; those at Bombay, Goa and Karaikal in 1980; that in Masulipatnam in 1981. The National Radar Council (NRC) set up in 1975 the Meteorological Radar Committee (MRC) in the Electronic Commission which recommended that Defence requirements of meteorological radars should be met by the IMD. The Indian Air Force (IAF) projected a demand for 3 radars and the Indian Navy (IN) for one radar. These radars may be capable of cyclone monitoring and may be stationed on a coastal location in which case these would be filling up the gaps of the Cyclone Radar Horizon (CRH). There is a possibility of one such radar will be located at Cochin in Kerala. A Directorate has been set up in Delhi for radar maintenance/development of radar operational techniques.

Legend

- ✚ : CWR established
- ⌖ : CWR proposed
- ✕ : Weather Radar
- ▴ : Defence Radar
- ● : Radar Stations in neighbouring countries
- ▬ : Cyclone Radar Horizon round the Indian coast

For numbers against stations in neighbouring countries refer to Table 2.43.

BHJ : Bhuj, BMB : Bombay, BNG : Bangalore, BWN : Bhubaneswar, CAL : Calcutta, CHN : Cochin, GOA : Goa, KKL : Karaikal, MDS : Madras, MNG : Mangalore, MPT : Masuli-Patnam, PDP : Paradip, TRV : Trivandrum, VSK : Visakhapatnam

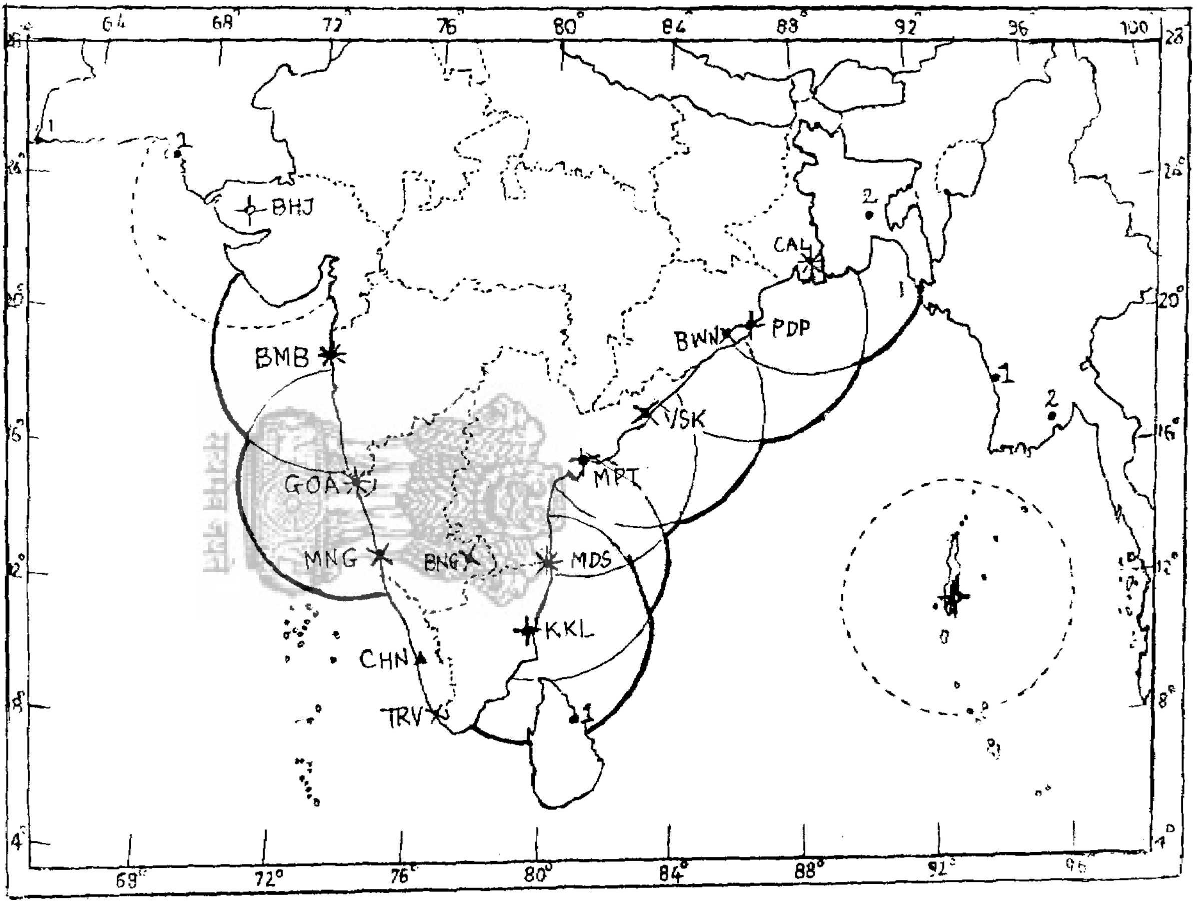


Fig.2.8 Cyclone Radar Horizon round the Indian coast. Reference 40 and Tables 2.6 and 2.43

2.51 THE CYCLONE RADAR HORIZON (CRH) AROUND THE INDIAN COAST :

Fig. 2.8 shows the part of CRH which is established at present. Sometime it is not sufficient to observe the cyclone by one radar only, because when there are intervening rain and cloud walls obscuring the sight of the eye or because of attenuation the observations from certain directions may be completely misleading. This was the case with the 1977 November Andhra Pradesh Cyclone. At that time the CWR-Masulipatnam was not in existence and the observation of CWR-Madras could not be cross checked. As a result the intensity of this cyclone was downgraded during the final crucial moments resulting in terrible consequences. A case study has been made of this cyclone in Chapter 5 (paragraphs 5.8-5.9). Since the CWR may have many other uses besides the detection of cyclone particularly during noncyclonic seasons, the installation of S-band CWRs are always advisable for closing up the gaps of the CRH. The Committee felt that the need of installing a CWR in Gujarat was very urgent as the state was visited by some devastative cyclones in the past decade. It may be seen from fig. 2.8 that the CWRs are so located that they are able to provide overlaping coverages so that distant cyclones are not missed or their intensities are not underestimated. The range of the CWRs is expected to be 400 km. But this is often reduced to 250 km or so when the cloud tops do not extend upto 10 km height. This stresses another reason for having overlapping CWRs. On account of absence of radar coverage on the west coast particularly in the Gujarat area, the Committee recommended

CRC/21 : The Cyclone Radar Horizon (CRH) round the Indian coast may be made more effective on the west coast by installing a Cyclone Warning Radar (CWR) at a suitable location on the Saurashtra coast.

2.52 REPLACEMENT OF CWRs :

The general experience has been that the CWRs suffer greatly from ravages caused by the saline environment and storm surges. It has been proposed to resite the CWR - Paradeep to a location inland to save it from erosion caused by salinity in the wind and water. The CWR-Masulipatnam has been installed on a building placed over high pillars. The CWR-Madras is now being resited on the top of the new multistoried Port Trust Building since it was being eclipsed by another nearby tall building. The CWR-Visakhapatnam is of 1969 vintage and belongs to the era of valve technology. It is being replaced by a CWR purchased from Enterprise Electronics Corporation of USA. The CWRs at Calcutta, Madras and Paradeep also need to be replaced.

2.53 AUXILIARY EQUIPMENTS AT THE CWRs :

Among the equipments available with the present set of CWRs, mention may be made of two Digital Video Integrator and Processor (DVIP) acquired with the MONEX programme, which are now integrated with CWR-Calcutta and CWR-Madras. This equipment is included in the CWR procured from USA for Masulipatnam. As the PPIs of the CWRs are fully occupied with routine operational/ warning/briefing it was proposed that two camera PPIs be put one at each of the CWRs at Calcutta and Madras to make possible uninterrupted photography (still/moving) of radar echoes. Most of the CWRs were provided with standby Diesel power and the necessary airconditioning for auxiliary equipments.

2.54 FACILITIES NECESSARY TO TRANSMIT RADAR IMAGERIES FROM THE CWRs TO THE RESPECTIVE AREA CYCLONE WARNING CENTRES/ CYCLONE WARNING CENTRES (ACWC/CWC)s :

Certain peripheral facilities are necessary with the CWRs. Continuous radar observations of a cyclone can give real time informations of the cyclones which the cyclone analysts needs for assessing evolution of the cyclone. To take full advantage of this important feature of radar observations the cyclone analysts and decision makers at the ACWC/CWCs need continuous visual displays of the radar imageries of the cyclones as soon as they are received. It is therefore necessary to provide voice grade communication links and terminal equipments for transmission of radar pictures from the CWRs to their respective ACWC/CWC. Table 2.7 give the location of the CWR stations vis a vis the associated ACWC/CWCs.

TABLE 2.7

RELATIVE LOCATIONS OF THE CWRs AND THEIR CORRESPONDING ACWC/CWCs

	Location of ACWC/CWC	Location of CWR	Interdistance
1. Bhubaneswar	Bhubaneswar Air port	False point Paradeep	110 km
2. Bombay	Colaba	Colaba	-
3. Calcutta	Alipore	New Secretariat Building	6 km
4. Goa Panaji	Bombay	N 10 Goa	430 km(from Bombay)
5. Karaikal	Madras	Beach Road Karaikal	250 km(from Madras)
6. Madras	Nungambakkam (Madras)	Port Trust Building	5 km
7. Masulipatnam	Visakhapatnam	Masulipatnam	352 km(from Madras)
8. Visakhapatnam	Visakhapatnam	Dolphin's Nose	10 km (from CWC-Visakhapatnam) 642 km(from Madras)

The Committee recommended

CRC/22 : There should be direct transmission facilities for radar pictures from the CWRs to their respective ACWC/CWCs when they are not both located at the same site. The ACWC/CWCs and the collecting centres should be interconnected with voice grade communication links and video channels for transmitting radarscope imageries on real time. The ACWC/CWCs should be equipped with facilities for video taping and playback systems and equipments for digitising the radar informations and arrangements for storage/retrieval of these imageries.

The Committee was informed that the IMD had plans to instal transmitting equipments at two CWRs and receiving equipments at the corresponding ACWC/CWCs.

2.55 RADARWINDS (SPA WINDS) :

By observing the motion of the echoes in the cyclone field on the Plan Posiition Indicator (PPI) of the radar, it is possible to estimate the wind fields. The height of the echoes are estimated by the Range Height Indicator (RHI). By these techniques the winds in the cyclone field can be estimated to a certain extent.

2.56 NEED FOR CONSTANT MONITORING OF A CYCLONE WHEN IT PENETRATES THE CRH :

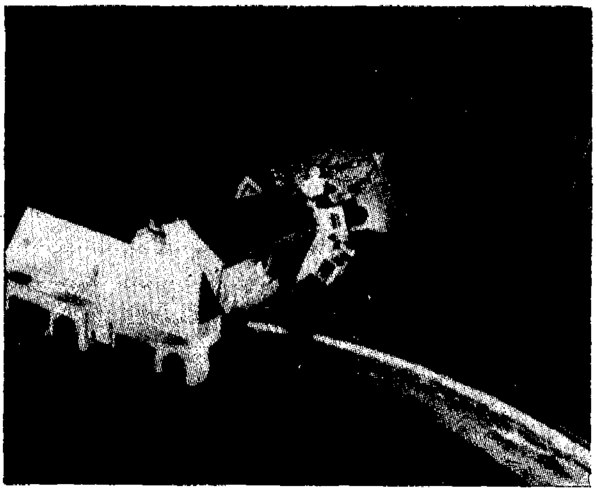
Normally the CWRs are operated once daily at 1130 IST. But from the moment a cyclone crosses into the radar horizon on the sea, the radar is operated once every three hours and later near the time of its landfall it may be observed hourly. Since sudden intensification to severe intensity or abrupt changes in track or looping may occur in between any two radar observations of a cyclone, it is essential that it should be kept under continuous surveillance after it has reached the cyclone stage. The Committee endorsed the recommendation of the IMD (IMDCP/5).

CRC/23 : A cyclone which has crossed into the CRH set at 400 km from the coast as determined by the normal range of the CWRs, should be kept under constant watch by these radars round the clock till it finally subsides.

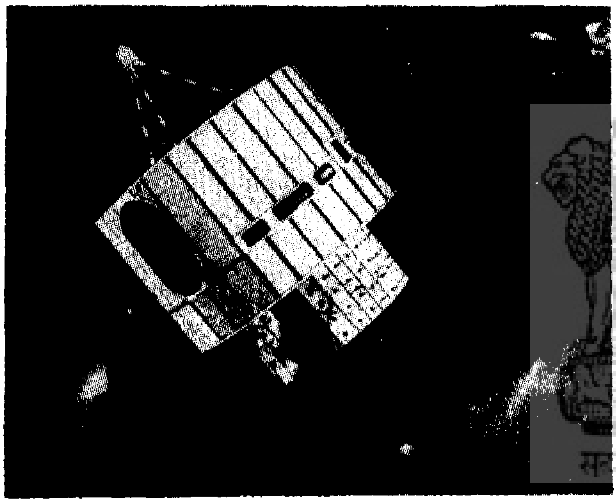
2.57 DOPPLER RADAR :

The Committee noted that the NRC has developed a Doppler Radar for measuring the air-motions within the cyclone storm directly. These radars are being used in USA and Japan. The Committee considered the working paper prepared on this facility which is summarised in appendix 2.6 (paragraph 2.331-2.333) and made the following recommendation.

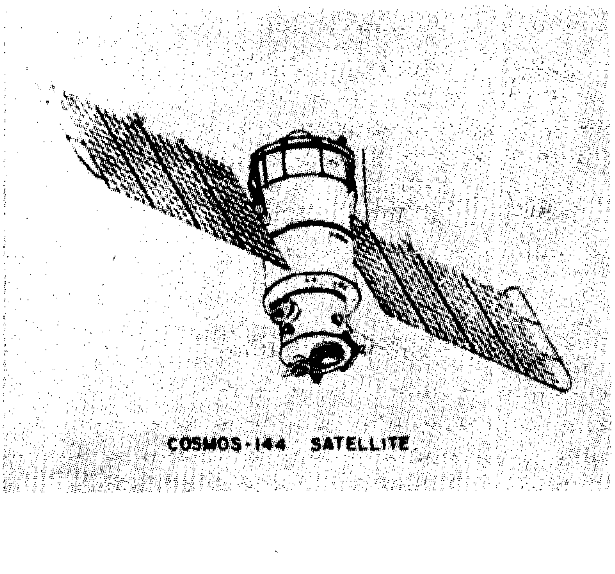
CRC/24 : While the capability of observation of wind structures within a cyclone by the Doppler radar is well realised,



NOAA Polar Orbitting Satellite (POS), : TIROS-N. Photograph obtained by courtesy of Mr. William S Barney of ICMSSR of NOAA.



GOES Satellite. Photograph obtained by courtesy of Mr. William S Barney of ICMSSR of NOAA



COSMOS 144 Satellite. Photograph obtained by courtesy of Dr. U. V. Gopala Rao of the IMD.

the technique is still under experimentation in USA and Japan and has not yet been put there into extensive operational use for cyclone monitoring. Moreover its usefulness in estimating the wind velocities at different levels in a cyclone system has yet to be established. A ground based Doppler Radar for cyclone monitoring was therefore not recommended. However as this was an emerging technique which may find many meteorological application for determination of velocities of wind and cloud masses, efforts may be made to make a beginning in the use of Doppler radar to study local storms like norwesters.

2.III.A(6) CYCLONE OBSERVATION BY SATELLITES

2.58 SATELLITE MONITORING OF CYCLONES (SMC) :

The limitations of the radar method of monitoring cyclones were noted in paragraph 2.49 above. One of the basic drawbacks is the limited range of a radar in tracking a cyclone. The surveillance of cyclones by satellites have the advantage that these can locate cyclones anywhere on the sea for beyond the radar horizon. Not only does the Satellite Monitoring of Cyclones (SMC) provides the earliest indications about them, the technique has also proved to be of great value because the cyclone parameters can be read off with ease and accuracy from the cloud imageries provided by the satellites as indicated by Dvorak (Chapter 4, Section III paragraphs 4.105-4.114).

2.59 SATELLITE INFORMATIONS ABOUT THE INDIAN AREA AVAILABLE AT PRESENT*

At present there are Polar Orbitting Satellites (POSs) (TIROS-N, NOAA-6) which view the Indian region twice a day taking low resolution pictures of the Bay of Bengal and the Arabian Sea areas. The transit times over India are : TIROS-N : 0830 hrs, 2030 hrs, IST; NOAA-6 : 1130 hrs, 2330 hrs IST. These pictures (day and night infra red pictures) are transmitted on real time in SAREP code FM85VI to the various Automatic Picture Transmission (APT) stations in India which have facilities to receive such pictures and transmit them to different centres of the IMD. USSR has been orbitting the COSMOS series of weather satellites taking global cloud coverage based on which global photo fascimile charts are broadcast. The pictures recorded by these satellites are received by the Hydrometeorological Service at Moscow and transmitted to Northern Hemisphere Analysis Centre (NHAC)-Delhi at Delhi by radio broadcast in the HF range via the Regional Telecommunication Hub (RTH-Delhi). Pictures received from the

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* IMD Cyclone Manual - Chapter 2

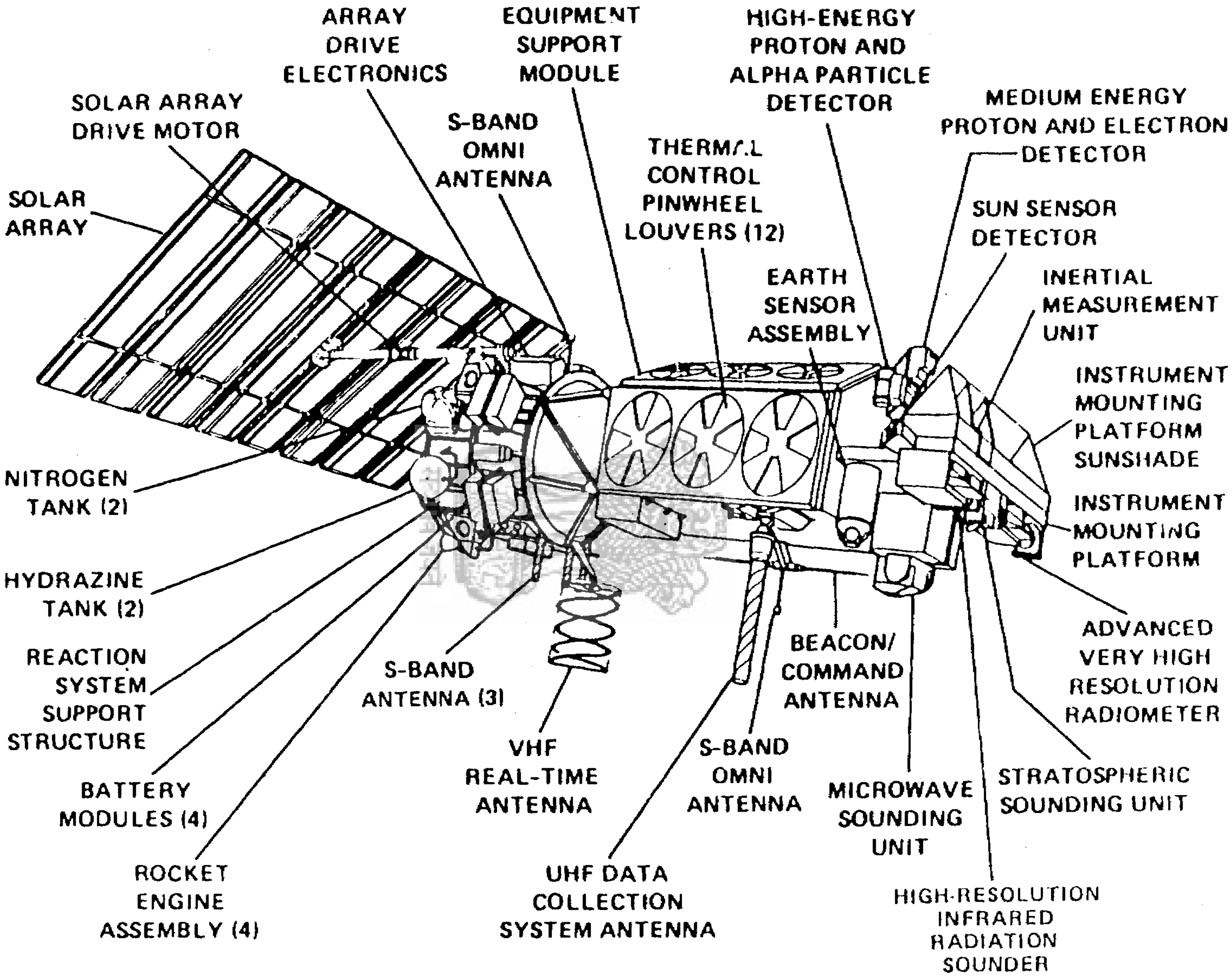
ARRAY DRIVE ELECTRONICS
EQUIPMENT SUPPORT MODULE
HIGH-ENERGY PROTON AND ALPHA PARTICLE DETECTOR
SOLAR ARRAY DRIVE MOTOR
S-BAND OMNI ANTENNA
THERMAL CONTROL PINWHEEL LOUVERS (12)
MEDIUM ENERGY PROTON AND ELECTRON DETECTOR
SOLAR ARRAY
SUN SENSOR DETECTOR
EARTH SENSOR ASSEMBLY
INERTIAL MEASUREMENT UNIT
INSTRUMENT MOUNTING PLATFORM SUNSHADE
NITROGEN TANK (2)
INSTRUMENT MOUNTING PLATFORM
HYDRAZINE TANK (2)
ADVANCED VERY HIGH RESOLUTION RADIOMETER
BEACON/ COMMAND ANTENNA
REACTION SYSTEM SUPPORT STRUCTURE
S-BAND ANTENNA (3)
VHF REAL-TIME ANTENNA
S-BAND OMNI ANTENNA
STRATOSPHERIC SOUNDING UNIT
MICROWAVE SOUNDING UNIT
BATTERY MODULES (4)
ROCKET ENGINE ASSEMBLY (4)
UHF DATA COLLECTION SYSTEM ANTENNA
HIGH-RESOLUTION INFRARED RADIATION SOUNDER

Fig.2.10 : TIROS-N : Schematic. By courtesy of William S. Barney of ICMSSR of NOAA

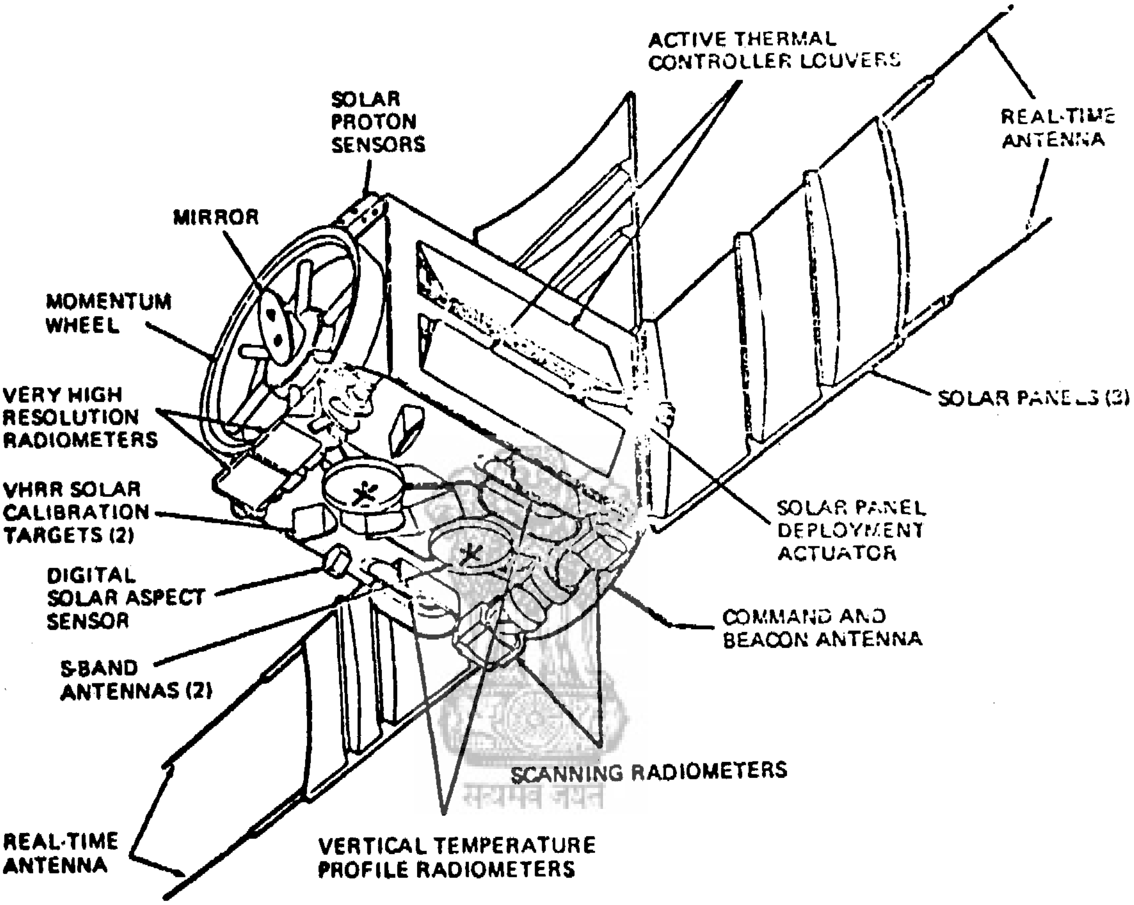

Fig.2.13 : Modified ITOS Satellite. By courtesy of Dr. U. V. Gopala Rao of IMD

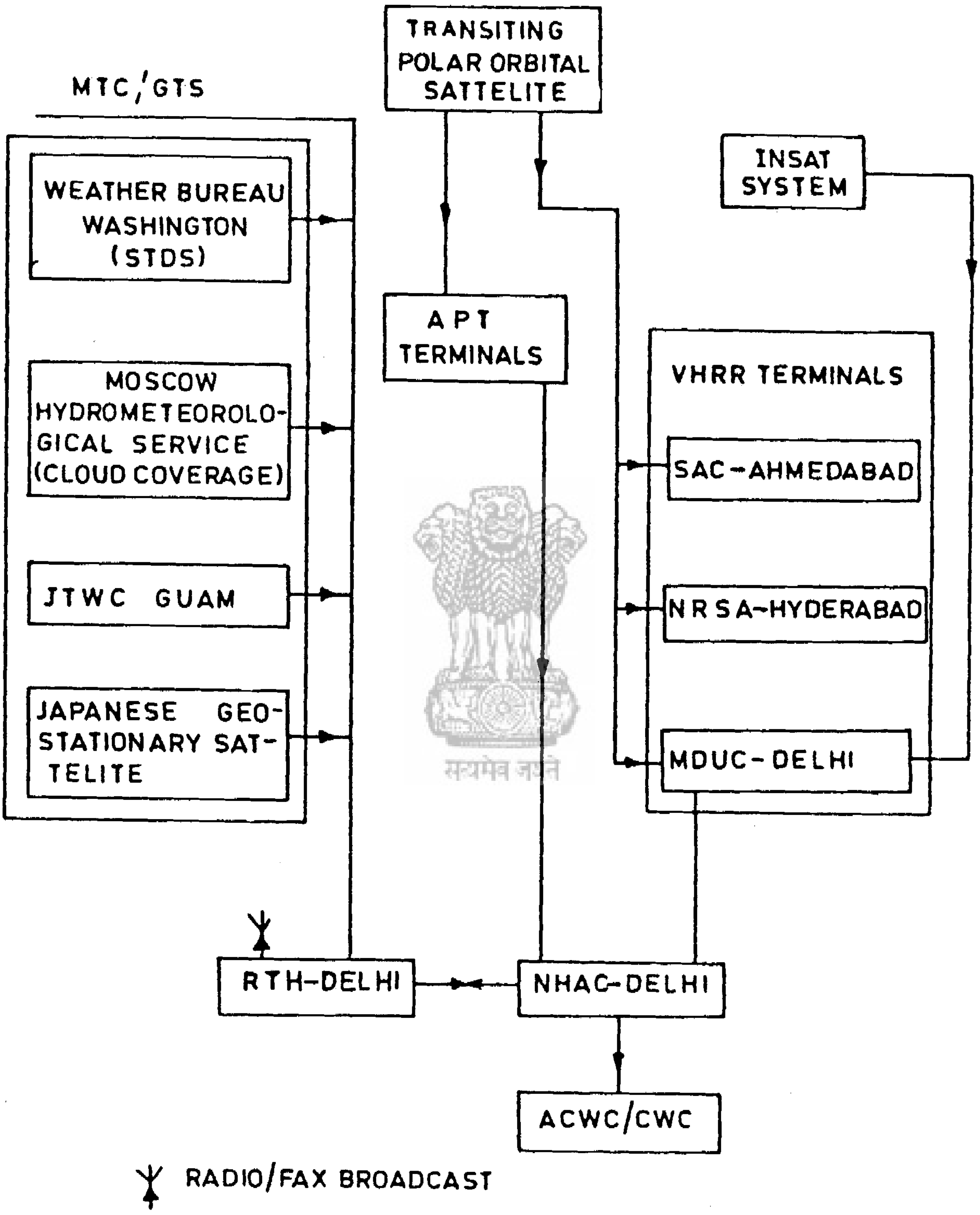
TRANSITING POLAR ORBITAL SATTELITE
MTC/GTS
INSAT SYSTEM
WEATHER BUREAU WASHINGTON (STDS)
MOSCOW HYDROMETEOROLOGICAL SERVICE (CLOUD COVERAGE)
JTWC GUAM
JAPANESE GEO-STATIONARY SATTELITE
APT TERMINALS
VHRR TERMINALS
SAC-AHMEDABAD
NRSA-HYDERABAD
MDUC-DELHI
RTH-DELHI
NHAC-DELHI
ACWC/CWC
RADIO/FAX BROADCAST

Fig.2.14 Satellite Data Collection System (SDCS) in India. Reference under VIII and IX in Chapter 8.1 and 38 and 39

satellites of other countries have to be paid for. Among the other satellite informations available from overseas mention must be made of the daily bulletins of cloud systems and estimated weather informations over the Indian seas and the Satellite Tropical Disturbance Summary (STDS) covering the location and intensity of any cyclone appearing in the Arabian Sea and the Bay of Bengal in Dvorak's T-code which are broadcast by US Weather Bureau Washington and received over the Global Telecommunication System (GTS) at the RTH-Delhi and analysed at the NHAC-Delhi. Since these informations are not received on real time, being received usually after lapse of twelve hours, they are not useful operationally but can be used for post mortem purposes. Another source of satellite information for the Indian region is the US Joint Typhoon Warning Centre (JTWC) at Guam based on pictures received through the satellities of Defence M Meteorological Satellite Programme (DMSP) of USA. It is usually difficult to get informations from these systems which are part of the Defence System of USA. Satellite assessed winds and sea surface temperatures for the Indian area east of longitude 90^{O}E are also now available from Japanese Geostationary Satellite standing over longitude 140^{O}E over equator in SATOB code - FM88VI EXTN. The purpose and functions of NHAC-Delhi, RTH-Delhi and other IMD data collection centres are described in Section IVA of this Chapter paragraphs 2.89, 2.105. Recently the Indian National Satellite (INSAT) programme has put two geosynchronous Satellite (GSS) into orbit one of which is non-operator. This programme is described in detail in paragraphs 2.64-2.66,2.110-2.115. The collection centres in India satellite data are shown in fig. 2.21.

2.60 SPECIAL FEATURES OF POLAR ORBITTING SATELLITES (POSs)* :

With the existing APT facilities in India, full use can not be made of the capabilities of the systems installed in the POSs. The position has however improved with the establishment of the Very High Resolution Radiometer (VHRR) terminal at Delhi (Paragraph). POSs have certain advantages :

1. Visible pictures are taken once a day (0900 hrs. IST) and therefore do not reveal diurnal changes. However Infra Red (IR) pictures taken at 2100 hrs. IST may also be requested if it is necessary, to examine the diurnal

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* Report on the improvement of Cyclone Warning System - prepared by the Meteorology Division of the Space Application Centre. (SAC-Ahmedabad).

changes. The day visuals received at the APT stations are not sufficient for cyclone monitoring. The IR pictures taken during the night should also be available for cyclone monitoring since both the US and USSR POSs make two passes each over the Indian region during the day and the night, it should be possible fomr visual and IR observations of a cyclone eye even when it is far out on the sea.

2. Each azimuthal segment of the satellite picture has the same sun angle. This makes easier brightness comparison of pictures taken at different satellite passes at different longitudes provided the latitude is the same.

3. The most important facility carried by POSs is the Advance Very High Resolution Radiometer (AVHRR or VHRR) which provides IR imagery of cyclones and their cloud structures. Geosynchronous Satellites (GSSs) also carry this facility but those abroad the POSs have much higher resolutions. Subsatellite point resolution of IR pictures from the VHRRs abroad the POSs (POS/VHRRs) is 0.8 km usually compared to 8 km available from the VHRRs abroad the GSSs (GSS/VHRRs). The high resolution available in VHRR-POSs make it possible to have good definition of convective cloud lines, narrow cirrus streamers, and the tops of small cumulonimbus clouds. The resolution of VHHR-POSs falls off at nadir angles intermediate between subsatellite point and the horizon. The VHRR facilities abroad various POSs are given in table 2.8.

TABLE 2.8

AVRR CAPABILITIES OF POLAR ORBITTING SATELLITES (POSs)*

Channel No.	Resolution at Sub-satellite point	Wave Length (um)	Primary Purpose
1	1 km	0.55-0.90	Day time cloud and surface mapping
2	1 km	3.55-3.83	Sea surface temperature, night time cloud mapping
3	1 km	10.5-115	Sea surface temperature, Day/Night cloud mapping

* Working paper 15 put before the CRC by the IMD

2.61 AUTOMATIC PICTURE TRANSMISSION (APT) FACILITIES IN INDIA*:

There are 8 Automatic Picture Transmission (APT) receiving stations (APTRSs) at ACWCs at Bombay, Calcutta and Madras and the CWCs at Bhubaneswar and Visakhapatnam and at the NHAC-Delhi, and the Weather Central (WC-Pune) and at Gauhati. Low resolution cloud imageries from the POSs are received at these APTRSs, once during the day and once during night. At some of the APTRSs, cloud pictures from METEOR satellite series of USSR are now being received also. The APTRSs are being strengthened for receiving pictures from TIROS-N. The Directorate of Satellite Meteorology of the IMD is responsible for data reception/utilisation of pictures from the POSs via the APTRSs and also for the design/development/fabrication of the APT equipments. The informations from these pictures are exchanged between these stations by Teleprinter (TP) channels of the IMD. The quality of the pictures needs improvement. The resolution deteriorates towards the edge of the picture making it difficult to locate the position of the eye and to assess the cyclone. The resolution for APT pictures for subsatellite point is usually 7 km only. It was also noted that the existing APT receivers manufactured by the IMD are not functioning satisfactorily. The Committee was informed that in the early stages of a cyclone the errors in locating the eye from these low resolution pictures may be as much as $1^{o}-2^{o}$ or 100 - 200 km. The error may reduce to within 100 km at more mature stages of a cyclone. It is clear that with the existing APT facilities in India, full use can not be made of the capabilities of the system abroad the POSs in a routine manner in particular of the VHRR capability. The VHRR terminals are now being set up in India, which may make it possible to receive the VHRR pictures from the POSs in some of these stations. The Committee felt that since the APT information, though imprecise at present is useful, and the technique may have to be used for many more years, the following recommendations by it is necessary.

CRC/25 : The present Automatic Picture Transmission(APT) receivers manufactured by the IMD and employed in Satellite Monitoring of Cyclones (SMC) by the Polar Orbitting Satellites (POSs) need improvement and should be replaced by receivers of better performance to improve the quality of the cloud imageries received. It was noted that IMD has already entrusted the work to the Bharat Electronics (BEL).

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* IMD Cyclone Manual : Chapter 2
CMAS - Notes on Agenda

CRC/26 : The APT receivers at the ACWC/CWCs should be capable of receiving the infra red cloud imagery broadcasts by the POSs passing over the Indian region during night.

CRC/27 : Since the pictures from the USSR meteorological satellites are received only at the Regional Telecommunication Hub (RTH) at Delhi, the IMD should arrange quick and prompt transmission of these pictures to the ACWC/CWCs.

2.62 GEOSYNCHRONOUS SATELLITES (GSSs)*:

The GSSs which stand stationary over the same geographic location on the equator have some advantages in the matter of cyclone monitoring :

1. The view that is available of the cyclone from a GSS is from the same relative vantage point. Comparison of such pictures taken at half hourly on command is an important technique in the hands of the cyclone analyst to follow the development of a cyclone even when it is far out on the sea.
2. GSSs can survey the whole of India and adjacent seas and thus the analyst can study much larger segments of the environment of a cyclone.

2.63 CYCLONE ASSESSMENT FROM THE VISIBLE AND INFRARED CLOUD IMAGERIES FROM THE VERY HIGH RESOLUTION RADIOMETERS (VHRRs) :

Satellites look upon cyclones from above unlike radars which view them from the side. The eye wall should be clearly seen in these pictures as well as the associated cloud bands. Many parameters of a cyclone can be assessed from the visible and infra red cloud imageries from VHRRs. A detailed discussion of assessment of a cyclone from radar and satellite imageries is given in Chapter 4 (paragraphs 4.100-4.114). A brief resume will be given here**.

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* Report on improvement of cyclone warning centre prepared by Meteorological Division of SAC-Ahmedabad.

** Estimation of tropical cyclone intensity and location from satellite cloud imagery - note prepared by Dr. D.K. Mishra of the IMD : Working paper 17 put up before the CRC by the IMD.

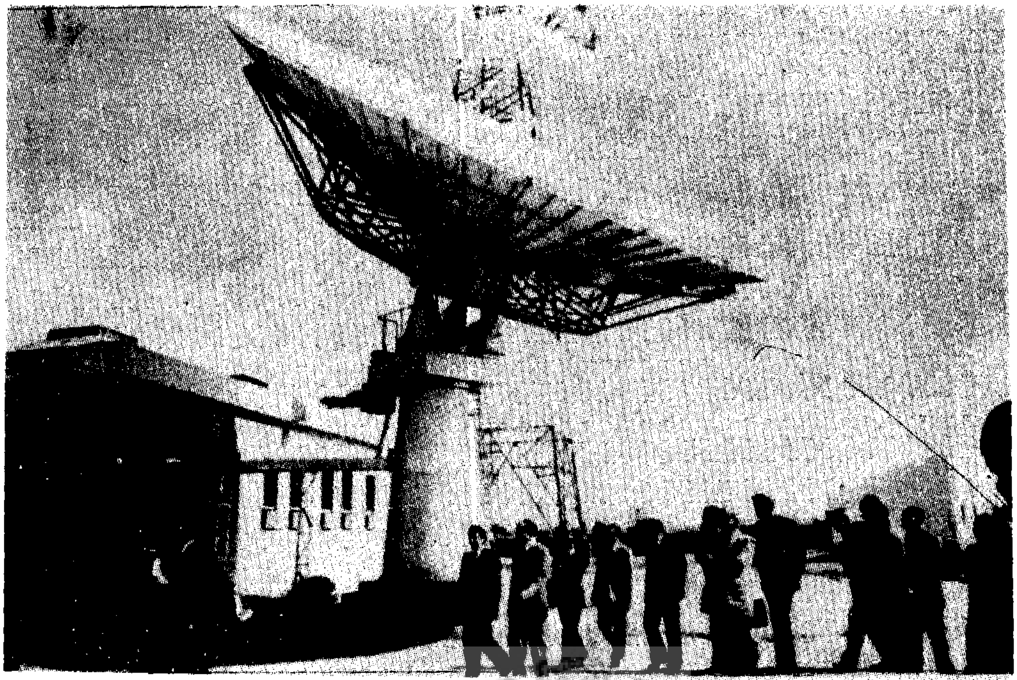
1. Dvorak's classification of cyclones : The cloud patterns associated with tropical cyclonesare of various well defined shapes depending on the type of atmospheric disturbance. The characteristics of the convective cloud feeder bands spiralling into the central features of the cyclone, the cirrus outflow and the central overcast cloudmass are related to the inflow, outflow, and the vertical motions in the cyclone. Dvorak has developed a T-number classification system correlating the cloud pattern with maximum wind speed (MWS) and the maximum pressure depth (MPD) at the centre or eye of the cyclone, The eye pressure depth can also be utilised to predict heights of storm surges. A chart giving Dvorak's classification is given in Chapter 4 (paragraph 4.109-4.110 fig. 4.8). Dovark's classification has been tested by aircraft probing of cyclones over the Atlantic and the Pacific oceans. This classification is now used throughout the world under the SAREF code enforced by the WMO. The average accuracy can be achieved by a trained analyst in estimating the MWS by this technique is about 8-15 kt i.e. 14.8-27.8 km/hr. The average error of estimation of minimum sea level pressure can be 7-12 mb. The work of Indian scientists had shown that Dvorak's classification can be extended to Indian cyclones if modifications are introduced. It is however necessary to cross check Dvorak's classification for Indian cyclone with direct observations (the socalled ground truths) by probing them by aircrafts.

2. Visible and Infra red VHRR imagery also yield wind and pressure data at different levels of a cyclone so as to give the analyst a fair idea of its three dimensional structure. The technique is based on :

   (a) determination of cloud movement determined from relative displacements from a consecutive sequence of pictures which gives estimates of wind speeds at the level of clouds analysed.

   (b) determination of the altitude of the cloud by observation of the nature of the cloud. The clouds are valuable indicators or tracers - there are many such tracers available at 850 mb level.

   (c) transformation of movement in the image space into wind vectors after correction of deformation of the image. A computer method has been



P&T Departmental Earth Station at Secunderabad. Photograph obtained by courtesy of Dr. U. V. Gopala Rao of the IMD.

INSAT-1 Satellite. Photograph obtained by courtesy of Dr. U. V. Gopala Rao of the IMD.

evolved for obtaining winds at different levels of a cyclone from the VHRR imageries from the GSS satellites.

3. VHRR imageries also give information on

   (a) sea surface temperatures,

   (b) cloud top heights,

   (c) cloud cover,

   (d) cloud temperatures, and

   (e) temperature gradients within a cyclone.

These parameters are also necessary for cyclone analysis.

4. Infra red monitoring of cyclones are possible also in the night time which therefore permits day and night surveillance of cyclones.

There is continuous research on the improvement of the quality of visible and infrared imageries from satellite and on techniques for interpreting them.

2.64 THE INSAT-1 PROGRAMME[*]:

The Indian National Satellite (INSAT) is a multi-disciplinary project approved in July 1977 by the Cabinet of the Government of India for the period 1978-1983. The various objectives of the programme are Meteorology, Telecommunication and Community TV broadcasts. The different organisations of the Government of India involved are Department of Space (DOS), Ministry of Civil Aviation and Tourism, Ministry of Communication and Ministry of Information and Broadcasting. The instruments through which the various objectives of the project are to be achieved are two geostationary satellites : INSAT-1A standing on 74°E Longitude at an altitude of about 36000 km, and INSAT-1B standing on 94°E Longitude. The estimated life time of the Satellites in orbit was seven years. The areas to be covered by each satellite is shown in fig. 2.17. The satellites were contracted with Messers Ford Aerospace Communication Corporation in USA. The agencies involved for the executive party of the INSAT programme were the DOS, the

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[*] CMAS : Notes on Agenda.

P&T Department and the IMD. The responsibility of establishment/operationalisation/maintenance/control of the space segment rests with DOS. The IMD is responsible for the INSAT Meteorological Application Programme (MAP). The essential features of this programme are

1. Obtaining both visual/infrared cloud imagery as seen by a Very High Resolution Radiometer (VHRR) aboard the satellite
2. Winds at two levels
3. Sea surface temperature (SST)
4. Cloud statistics
5. Snow cover.

The scientists of the IMD have been trained at NESS for familiarity with the techniques of

1. Wind vectors derivation
2. Hydrology interpretation
3. Infra red temperatures determination and analysis
4. Gridding and navigation systems
5. Computer programmes

The meteorological packet of instrument on board the satellites consists of

1. VHRRs working in visual/infra red ranges of the electromagnetic spectrum for imaging the cloud cover over India and adjoining lands. The nominal ground resolution in the visible channel is 2.75 km and in the infrared channel is 11 km.
2. A data collection transponder for relaying meteorological/hydrological/oceanographic data transmitted from the unattended autotelecasting land/sea based DCPs.

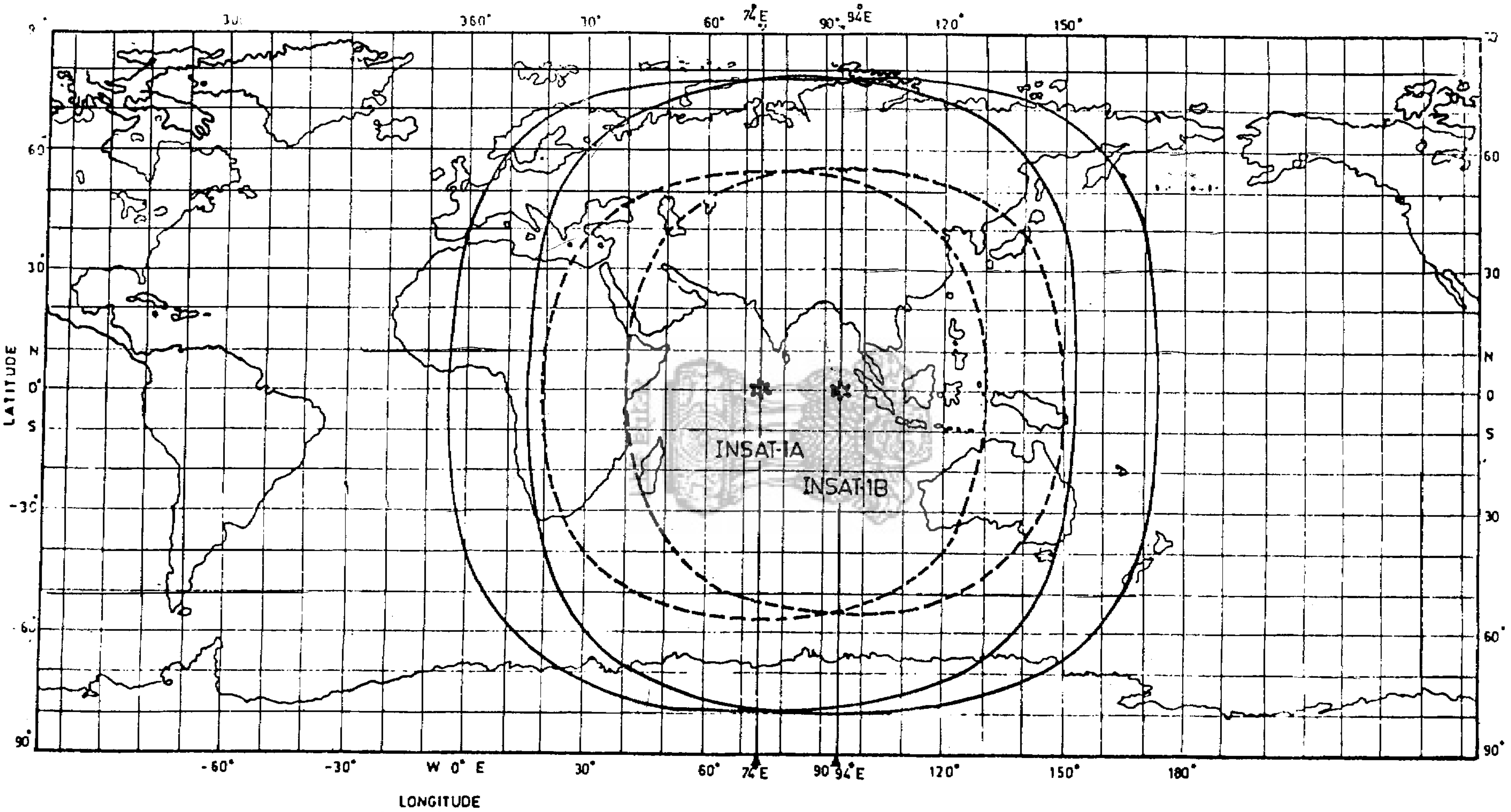
There are provisions for frequent pictures (every six minutes) over a limited area of interest for monitoring rapidly developing weather phenomena. On the meteorological segment there is a back up computer - IBM System 360 which is being shared. It is proposed to replace it by another system with 2 million bytes capacity. The IMD is also responsible for

1. Setting up of a Meteorological Data Utilisation Centre (MDUC) for processing of INSAT VHRR/DCP data and generation of user oriented products from them.
2. Establishment of twenty Secondary Data Utilisation Centres (SDUCs) for receiving processed data from the MDUC.
3. Installation of the DCPs in remote inaccessible areas for transmitting meteorological data of the environment to INSAT for onward reception at MDUC.
4. Establishment of a Disaster Warning System (DWS) which can be used for cyclone warning.
5. Augmentation of P&T Earth Stations.

The telecommunication/community TV broadcasts were the responsibilities of the P&T Department and the Ministry of Information & Broadcasting. The P&T Department is responsible for establishing the various Earth Stations for communicating with the satellites. For integrating and coordinating the activities of the different agencies responsible for the INSAT programme during the implementational and operational phases and for future planning. The Government of India constituted a high level Committee of Secretaries named the INSAT Coordinational Committee (IOC). A technical Advisory Group (TAG) consisting of the representatives of the Ministries concerned and the Department of Space and the Wireless Adviser of the Government of India deals with all technical and functional matters reporting to the ICC for final implementational decisions. The organisations for meteorological segment of the INSAT programme and the method of satellite data collection are described in Appendix 2.7 paragraph 2.334, table 2.44.

2.65 LAUNCHING OF INSAT-1A :

On April 10, 1982, the first of the two proposed geostationary satellites was put into its allotted parking position over the equator. Unfortunately there were onboard



- DCP coverage -------- Imaging coverage

Fig. 2.17 : INSAT Meteorological Cover. References 69 and 68.

system failures from the very beginning. The solar sail failed to open, and in attempting to set matters right there was drastic depletion of onboard fuel. By September 6, 1982 all systems aboard INSAT-1A stopped obeying any ground commands. The next satellite in this series INSAT-1B has been launched in September 1983.

2.66 THE ROLE OF INSAT IN CYCLONE MONITORING :

It will be seen in paragraph 2.64 that the meteorological segment of INSAT-1A was of considerable size and should have been a very important facility for cyclone monitoring/ assessment/dissemination of information/early disaster warning. The most important capability of these satellites is that of keeping a cyclone under constant watch; every half hourly view of the cyclone could be transmitted on real time to the Meteorological Data Utilisation Centre (MDUC) at Delhi and the derived informations could be transmitted to the ACWC/CWCs. During its short period of its existence INSAT-1A transmitted excellent pictures of the 1982 June Orissa cyclone.

2.67 THE VHRR STATIONS IN INDIA :

At present there are three uncorrelated VHRR picture receiving stations in India. The Satellite Application Centre (SAC) set up in 1978 which is an experimental VHRR terminal at Ahmedabad of its own design to receive the NOAA-6 VHRR pictures on real time. It has been proposed that this facility should be augmented. The National Remote Sensing Agency (NRSA) has also set up a VHRR terminal at Hyderabad. The IMD has set up a VHRR terminal at New Delhi to receive the very high resolution pictures of cloud imageries in the Indian region on real time as direct read out data which will be in digital stream. This receives US POS imageries four to five times daily. The system also provides capability for receiving pictures in five spectral channels for detailed study of clouds with different weather systems. The high resolution pictures have improved the real time warning systems against adverse weather. The details of the mode of transmission of VHRR data and the data products produced are given in paragraph 2.70.

2.68 NEED FOR INTERACTION BETWEEN THE VARIOUS VHRR TERMINALS IN INDIA :

The Committee considered the various aspects of the INSAT programme and considered it to be a very valuable addition to existing cyclone detection machinery. Regarding the VHRR terminals being set up by various agencies, the Committee felt that they should interact with each other very closely during a cyclone regime. It recommended

CRC/28 : The Very High Resolution Radiometer (VHRR) terminals set up at Satellite Application Centre (SAC) at Ahmedabad, the Meteorological Data Utilisation Centre (MDUC) at Delhi and the National Remote Sensing Agency (NRSA) at Hyderabad and any others that may be set up in the country, should be closely integrated with each other and with the neighbouring ACWC/CWCs for maximum efficiency for cyclone detection and assessment.

2.69 PROPOSAL FOR INSTALLING VHRR TERMINALS AT THE ACWC/CWCs :

A question was raised whether the different ACWC/CWCs should have their own VHRR terminals also. It was felt that the VHRR terminal at Delhi of the IMD would have much greater capability than what would be possible if such terminals were established at the different ACWC/CWCs. The reasons for this lie in the highly expensive nature of the equipments and the high degree of sophistication of the technology involved. Because of the expertise available at the various units of the IMD at Delhi and in particular the large computer facilities installed there, the satellite data could be much more thoroughly analysed and processed at the Delhi Satellite Centre and the MDUC, which could then be transmitted to the ACWC/CWCs by the IMD Telecommunication links. The Committee therefore recorded its opinion.

CRC/29 : It is not advisable to set up VHRR terminals at the individual ACWC/CWCs. The expertise, analysis facilities and sophisticated technologies available at the various units of the IMD at Delhi are adequate for the purpose of analysis of satellite data on cyclones. The analysed data can be easily and immediately transmitted to the ACWC/CWCs by the telecommunication links of the IMD.

2.70 PROCESSING OF VHRR DATA RECEIVED VIA INSAT*:

The INSAT-1 VHRR/DCP is processed at the Meteorological Data Utilisation Centre (MDUC) described in paragraph 2.95.

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* CMAS Meeting : Notes on Agenda.

The VHRR/DCP data stream would be received at the Twin Satellite Operation Earth Station (TSOES) at Delhi more commonly called Delhi Earth Station (DES) located at Secunderabad 60 km from Delhi in U.P. established by the P&T Department. This data would be mixed with the satellite performance data synchronisation/VHRR altitude/onboard calibration information. The digital stream would be sent by INSAT to DES on the 4 GHz career. The data would then be sent to the MDUC over a microwave link via the Delhi Microwave Station at Rajendranagar. The data would be processed at MDUC round the clock and various user oriented products would be generated for dissemination. There are provisions for archival/retrieval facilities for selected processed data for later use. The hardwares available at the MDUC are for

1. Preprocessing stage : The raw incoming data stream will be first tested for quality. At the preprocessing stage the VHRR data stream would be seperated from the satellite performance data by a mini computer. The separated VHRR data would be reformated for further processing and generation of imageries. Certain corrections have to be applied now before generating the final cloud pictures. The telemetry data covering orbit information, altitude and onboard sensor data, would be monitored for transmission errors and then used in processing a VHRR data through another computer. The hardware for this are a BIT synchroniser, type recorders and specially designed computer based processing units. There are facilities for monitoring the different stages of preprocessing on CRT display units. The telemetry would also be monitored/displayed/printed out as required.

2. Data processing : The data processing subsystem consists of two processing computers, one operational and two other standby - with core memory, auxiliary storage, controllers, desk packs, CRT displays, printer peripherals.

3. Interactive displays : The interactive subsystem has its own micro-computer which has a special purpose memory and three display devices for satellite pictures, graphics and numerical data. The subsystem consists of a console for introduction of commands for operation. The objective here is to extract and derive important meteorological information such as wind vectors, sea surface temperatures and heights etc.

4. Visual product subsystem : This subsystem consists of equipments for the generation of positives/ negatives of cloud pictures every half hour for both visual/infrared channels, preparation of movie loops and cloud pictures for the areas of interest using master negatives. The equipment consists of laser facsimile recorders, animation camera, movie processing equipment, and equipment for taking photographic copies from master negatives. In addition copies of charts/diagrams/other documents, output products are prepared by ammonia printing/ electrostatic coping/roneoing process.

There is a MDUC maintenance laboratory taking care of all the hardwares/equipments. The following data products available at the MDUC would be

1. Full/Sector frame cloud cover pictures in the visible/infrared channels. Certain features on the imageries can be enhanced and displayed on CRT of the interactive terminal.

2. Himalyan snow cover pictures once every day

3. Cloud cover movie loops two to four times daily

4. Sea surface temperature (SST) charts once every day

5. Cloud top temperatures (CTT)/Cloud Cover Heights (CCH) two to four times daily

Analysed data product produced by MDUC would be

1. Detection/location of various meteorological phenomena of different scale

2. Detection/location of cyclones

3. Determination of cloud type/amount over different geographic areas

4. Observation of hydrological parameters like the extent of snow cover, water bodies etc.

5. Derivation of wind vectors from cloud motions.

The analysed data would be produced in close colaboration with forecasters of IMD at Delhi and other places.

2.71 PROCESSING OF DCP DATA RECEIVED VIA INSAT*:

The DCPs consists of two main components

1. Sensors/associated electronics for collection of meteorological/hydrological/oceanographic data. The meteorological sensors have been discussed in paragraph
2. Data conversion, Storage and Transmission Sub-system (DCSTS) for transmission of data gathered to INSAT. The Committee was told that the design of DCSTS was finalised and the contractors for manufacture of this item also finally selected.

The DCPs will transmit their data on

1. Wind speed/direction
2. Air temperature
3. Relative humidity
4. River levels
5. River flow rates
6. Atmospheric pressure
7. River/sea temperatures

to the satellite borne data transponder on the 402 MHz carrier The mode of transmitting data to INSAT is what is called the random burst mode which consists of a series of signals sent at given intervals. The data will be retransmitted to the MDUC via DES on the 4 GHz carrier. The DCP data stream will be available as a separate data stream independent of the VHRR stream. The data will be processed/retrieved at MDUC for meteorological/hydrological/oceanographic parameters for different DCO locations. The output data of various meteorological elements can be disseminated by IMD's telecommunication net work. Processing and dissemination of DCP data can be done using a microprocessor or minicomputer. The DCP data processing/dissemination would be done round the clock.

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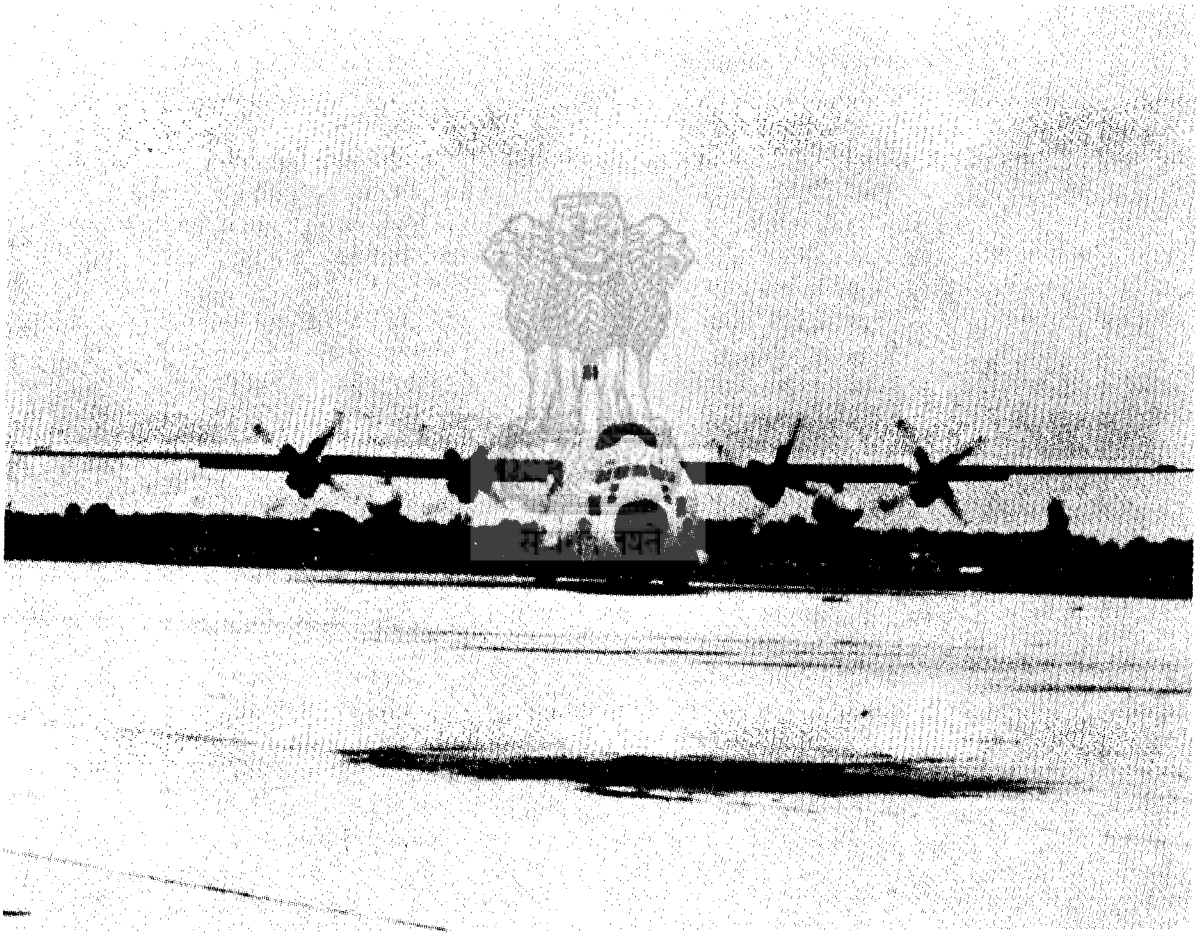
* CMAS Meeting : Notes on Agenda.

2.III.A(7) AIRCRAFT PROBING OF CYCLONES (APC) :

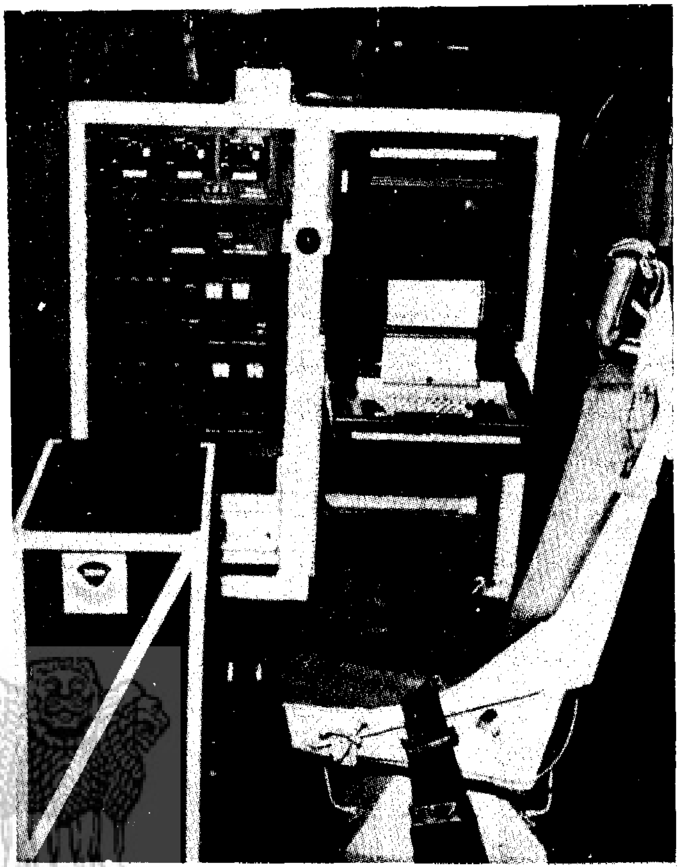
2.72 NECESSITY FOR APC :

On the sea the only reliable and direct method at present of measuring the meteorological parameters of a cyclone is to penetrate it by aircrafts and probe it with sophisticated self recording instruments. Aircraft probing of cyclones (APC) provide the most accurate and upto the minute informations of the eyes and intensities which are of great value for forecasting of the movements. APC provides the only method of determining the three dimensional structures of cyclones which extend from the sea level to the troposphere at 17 km and beyond. Ships on high seas may easily miss the cyclones though they may be carrying all the necessary monitoring instruments. The other methods discussed previously are indirect in nature from which inferences have to be drawn which can gain credibility only if cross checked by direct observations. Cyclone probing by instrumented aircrafts are routinely undertaken in USA and Japan for more than two decades but are not still available in this country. The Committee noted that Dvorak classification of cyclone types deduced from observed configuration of closed structures was established by aircraft probing of cyclones over the Atlantic and the Pacific oceans. It was however absolutely essential to cross check the classification to see if it is applicable to Indian cyclones also, or whether some modifications are necessary. For this purpose it would be desirable to correlate wind velocities, pressure depths and other cyclone parameters and three dimensional structures by recording these data by cyclone probing aircrafts (CPAs). Such probing is also useful for studying the dynamics of cyclone formation, development, movement and decay and for setting up of proper cyclone models which is essential for developing techniques for understanding and predicting cyclone movements and associated storm surges more accurately. The measurements by CPAs should be correlated to cloud structures and configurations of cyclones observed in cyclone imageries recorded by the INSAT-1 and CWRs. APC on regular basis for every cyclone as done over the Atlantic and Pacific oceans are essential for forecasting the tracks 24-72 hrs ahead by sophisticated models and computations. Reconnaissance should be done at three levels in the atmosphere roughly at 1 km, 6 km and 12 km a.s.l. The question of cyclone probing by aircrafts was discussed by earlier Committee also. The Committee recommended

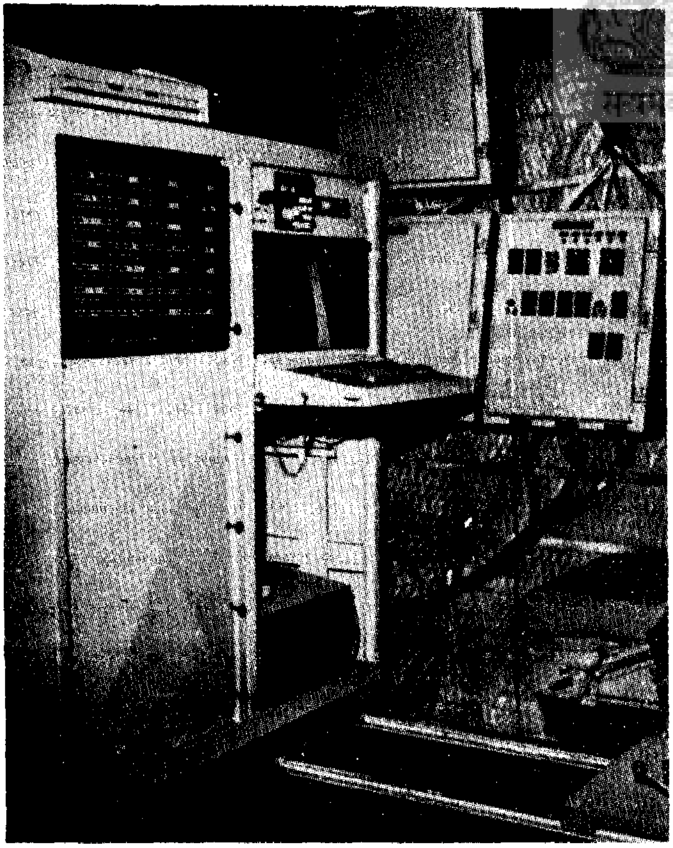
CRC/30 : It is absolutely essential to prepare a classification of cyclones for the Indian region by correlating



A hurricane probing aircraft. Reference 92



Vertical Observation System—Omega Dropsonde system aboard WC-130 aircraft. Photograph obtained by courtesy of Mr. William S. Barney of ICMSSR of NOAA.



Horizontal Observation System aboard WC-130 aircraft. Photograph obtained by courtesy of Mr. William S. Barney of ICMSSR of NOAA.

the measurements on the Indian cyclones by Cyclone Probing Aircrafts (CPAs) with the data from the cyclone imageries recorded by satellites and the CWRs. Such aircraft probing of cyclones (APC) are also important for microstudies of all cyclone parameters and detailed analysis of their structures and for improving the forecasting capabilities of the ACWC/CWCs. It is expected that such studies would lead to deeper understanding of cyclone dynamics - their formation, development, movement and decay to setting up useful cyclone models.

2.73 SPECIFICATIONS OF CYCLONE PROBING AIRCRAFTS (CPAs) AND ONBOARD INSTRUMENTATION FACILITIES AND OTHER PARTICULARS* :

The Committee considered in detail the techniques of probing cyclones with aircrafts. It was pointed out that aircrafts probing may be the most modern method of studying all the parameters of a cyclone. A review of the APC techniques as used in USA for the Atlantic Ocean, Gulf of Mexico and Pacific Ocean regions is given in Chapter 4 Section IV (Paragraph 4.116-4.128). The Committee also noted that the hazards of flying aircrafts through cyclones were of much greater magnitudes compared with these of normal transport aircraft flights but can be taken care of by competent pilots specially trained for cyclone probing. It was noted the proposal of the IMD of acquiring an aircraft with appropriate measuring instruments. The Committee supported this proposal. The types of aircrafts suitable for cyclone probing were also discussed, taking in consideration the experience of the USA centres. Study of these experiences should provide sufficient guide lines to plan concretely the APCs. There was no question of an aircraft designed and built solely for meteorological probing and research because of prohibitive costs. Thus the aircrafts used for the commercially available ones with the following task capabilities**

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* Working papers No. 9,10,11,12 placed before the Committee by the IMD

** Working paper No.12 by Shri K. Chatterji put up to the Committee by the IMD

TABLE 2.9

OPERATIONAL CAPABILITIES OF CYCLONE PROBING AIRCRAFTS (CPAs)

Task	Capability
1. Height of operation	150-9000 meters
2. Hours of flight endurance	12-14 hours
3. Length of track	3000 n miles
4. Cruising altitude	6000 m
5. Cruising speed	150-300 kts

Structurally such aircrafts should be able to withstand a load factor 2-3G. The CPAs used in USA are usually DG-6, WC-130 (Hercules), B-57, WP-3D (Orion). DC-6 is a four engine piston long endurance aircraft; B-57 is a two engine jet, WC-130 and WP-3D are four engine turbo propelled long endurance aircrafts. The clearance between the belly and the ground of WC-30B is too small to house a belly weather radar which is a size quo non for weather probing aircrafts. A comparative study of the aircraft capabilities and instrumentation abroad necessary for probing is given in appendix 2.8 paragraphs 2.335-2.338. The Committee recommended as follows :

CRC/31 : The CPAs should be long endurance aircrafts with maximum range of 2500 miles and must be aerodynamically suited to stand up to the stresses of flights through cyclonic conditions. Four engine turboprop aircrafts are usually used for cyclone probing and may be used to study Indian cyclones also.

CRC/32 : The CPAs should have the capability of installing a belly radar in it. The following instrumental facilities were suggested for installation in the aircrafts :

1. Instruments for measurement of meteorological parameters : (a) total/free air temperatures, (b) atmospheric pressure - static, (c) atmospheric pressure - differential,

(d) pilot head, (e) flight level wind, (f) dew point, (g) sea surface temperature, (h) wind, (i) temperature-vertical profile, (j) humidity - vertical profile, (k) pressure-vertical profile, (l) radar altitudes.

2. Instruments for cloud physics : (a) clound liquid water contents, (b) total liquid water contents, (c) hydrometeorsize spectra (cloud droplets/hydrometeors).

3. Suitable meteorological radars : (a) bally radar C-band PPI 360° scan (horizontal) fan beam radar, (b) nose radar for weather RCA AVO 30, (c) nose radar C-band PPI 240° scan (conical).

4. Onboard photographic systems : a) sea state photography (looking down), (b) time elapse cloud photograph (side looking), (c) data panel photography, (d) radarscope photography recording.

5. Onboard data recording system : (a) Two recording systems - one dedicated to meteorological cloud physics, radiation sensors and lN system, and the other to the nose and lower fuselage, (b) a suitable onboard mini-computer and necessary peripherals.

CRC/33 : For planning the Aircraft probing of cyclones (APC) a Directorate of APC should be established with the necessary support from the IMD to take decisions on probing flights, flight plans, installation/procurement/maintenance of instruments aboard the CPAs and to interpret the results of observations and to transmit the results to the forecasting centres including the ACWC/CWCs.

CRC/34 : For telecommunication (TC) linkage with ground stations the IMD should be assigned special frequencies for use to establish two way communication between the CPAs and the base stations on ground.

CRC/35 : The CPAs may be used during noncyclonic seasons for other atmospheric studies like investigations of monsoon depressions, cloud physics, sea state studies etc.

CRC/36 : The maintenance and operations of the CPAs should be given to agencies like the National Remote Sensing Agency (NRSA) or to the Indian Air Force (IAF).

CRC/37 : Proper training of the CPA mission scientists, technicians, and crew members should be organised as done in the Research Flight Centre (RFC) at Miami USA. The training should include flying the aircraft under cyclonic conditions, planning probing flight patterns in the field of the cyclones, conducting meteorological experiments under cyclonic conditions and interpreting data thus acquired and other similar tasks that would be necessary.

CRC/38 : The CPAs may be acquired as expeditiously as possible.

2.74 NUMBER OF CPAs NECESSARY :

The Committee also went into the question of the number of aircrafts necessary to probe a cyclone satisfactorily. It was informed that ideally aircraft probing should be done at three levels : low, medium and high ranging from 5000-30000 ft. A number of aircrafts should probe a cyclone either sequentially one after another or collectively spread out in different altitudes according to a strict flight plan to avoid collisions as is done in USA. This is necessary because simultaneous informations at different altitudes are useful for assessment. Ideally 6 CPAs would be necessary for a satisfactory probing of a cyclone. The Committee realised that the APC project has been gestating for a long time since the first time IMD made the proposal to the IAF. The Committee recommended

CRC/39 : More than one APC may be necessary for probing a cyclone. These may be acquired gradually in phases under the aegis of the WMO/ESCAP Panel on tropical cyclones as a part of a regional project.

2.III.A(8) OTHER TECHNIQUES OF STUDYING CYCLONES AND SURROUNDING NEIGHBOURHOOD :

2.75 OTHER EMERGING TECHNIQUES FOR CYCLONE MONITORING :

The Committee discussed the other emerging techniques of studying cyclones and their neighbourhoods. The most important of them are : (1) measurement of the state of the sea by downward looking lasers in particular measuring wave heights and (2) interference by the state of the sea on the ionosphere as revealed from ionospheric measurements* Laser techniques could be used for the first method. Laser sensor should be easily fitted to the CPAs. With respect to the second technique a close collaboration is needed between the IMD and the various research groups on Ionospheric studies in India. The Committee recommended

CRC/40 : There is need to develop expertise by the IMD on the investigation of the state of the sea by downward looking lasers by sending its scientists abroad for training. The instrument packet aboard the CPAs may be reinforced by the addition of these laser equipments.

CRC/41 : The IMD may organise research programmes with various research groups in the country to investigate the possibility of using a HF radar in the ionosphere scatter mode to study the state of the sea and correlate it with the parameters of a cyclone in the area.

Study of the sea surface can give ship observers some indication of a cyclone when it is out on sea. The swell as distinct from the waves (called the sea) which is caused by local winds are waves moving out far from the place of origin by cyclones; the swells can be easily distinguished from the sea and are cyclone indicators. If the direction of the swell remains constant, the cyclone is either approaching or receding from the ship. If the direction changes anticlockwise the cyclone is passing the observer from his right to the left. Similarly if the change is clockwise the cyclone is passing the observer from his left to his right. The Committee recommended

CRC/42 : Data on the swells on the sea as observed on ships should be regularly reported to the ACWC/CWCs when they are of a nature indicative of cyclone formation.

2.III.A(9) RAIN GAUGE/TIDE GAUGE/STORM SURGE GAUGE STATIONS(RGS/TGS/SSGS) IN COASTAL INDIA

2.76 HAZARDS ARISING OUT OF OVER PRECIPITATION AND STORM SURGES :

The greatest threat to life and property arises out of heavy downpour of rain and violent storm surges which are often the inevitable results of a cyclonic storm. It is therefore necessary to forecast these hazards as much in advance as possible. The main instruments that are used are the raingauges (RGs) and Tide gauges (TGs). The use of these instruments for cyclone monitoring will be discussed in the following paragraphs. The Flood Forecasting Organisations (FFOGs) in the country will be discussed in paragraph 2.103-2.104.

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* Suggested by Dr. A.P. Mitra, Member of the Committee. Details given in appendix 2.9 (paragraphs 2.339-2.342).

2.77 RAIN GUAGES (RGs)* :

Rainguages have been installed in large numbers in the important catchment areas and river basins. Both ordinary RGs (ORGs) requiring reading by observer and self recording RGs (SRRGs) are widely used for assessing precipitation for purpose of flood forecasting. Both types are made at the Instrumentation Division at Pune. It has also become the practice to instal a WT station in proximity with a RGs so that the data can be transmitted to the FFOGs on real time. The Committee was informed that during the day it took about 30 minutes by the observers to record rain falls with ordinary RGs. Since most of the RGs are read by part time observers, it is not certain how reliable the observations are. The Committee recommended

CRC/43 : The ordinary Rainguages (ORGs) used in the CPARs should in course of time be replaced by Self Recording Rain Guages (SSRGs).

2.78 TIDE GUAGES (TGs)* :

IMD has no expertise in the design development/installation/maintenance of TGs. These instruments have so far been installed/maintained by the Survey of India and organisations like the Port Trusts. IMD conducted the excellent survey of all types of water level recorders, storm surge recorders, wave recorders etc. and their recording systems that are in use in the country and abroad. Discussions were held by IMD Scientists with those from

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* IMD Standard Brief (1983)

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1. Central Water and Power Research Station (CWPRS) at Pune
2. National Institute of Oceanography (NIO) at Goa.
3. National Physical Oceanographic Laboratory (NPOL) at Cochin
4. Survey of India at Dehradun.

It appeared that only NIO had the necessary infrastructures and organisation to undertake a pilot project on design/ manufacture of TGs suitable for cyclones. NIO has agreed to act as the agency to provide capital equipment and instal a TG at Karaikal on an experimental basis for the period of duration of the project of 2-3 years.

2.79 EXISTING TGSs :

The Geodetic branch of the Survey of India had set up 19 Tide Gauge Stations (TGSs) along the eastern and western coasts of India and these are maintained by this organisation. Many other organisations have also their tide gauges on important rivers in coastal states. Thus in West Bengal the Port Commission Calcutta maintain fifteen TGSs and the State Government three on the Hooghly and the Roopnarayan river. These tide gauges are meant primarily to measure normal tides and are not suitable for measurement of storm surges. Indeed the present tide gauge stations are grossly inadequate to stand up to cyclones. In fact serious doubts were expressed in the meetings of the CRC whether they function at all during cyclone emergencies and whether heights of storm surges were infact estimated indirectly from the level of the debris and artifacts left behind by the cyclone storm surges. The Committee recommended

CRC/44 : The tide measuring instruments set up at the Tide Gauge Stations (TGSs) on the coastal regions of India should be strengthened to be able to stand up to the fury of the cyclones. The instruments for measuring tide levels should be redesigned to be able to measure cyclonic storm surges.

2.80 DISTRIBUTION OF EXISTING TGSs IN COASTAL INDIA* :

According to an assessment given by the IMD, 15 more tide gauge stations have been installed in the coastal region of India making a total of 34 in all. The distribution of the TGSs established by the Survey of India in the different coastal states of India are given in Table 2.11

TABLE 2.10

DISTRIBUTION OF TIDE GAUGE STATIONS (TGSs)
IN COASTAL INDIA

State	Existing	Proposed	Total
1. Andhra Pradesh	1	4	5
2. Goa	1	-	1
3. Gujarat	4	3	7
4. Karnataka	2	-	2
5. **Kerala**	1	2	3
6. Lakshadwip Group	1	-	1
7. Maharashtra	2	1	3
8. Orissa	1	2	3
9. Tamil Nadu	3	3	6
10. West Bengal	3	-	3
Total	19	15	34

A list of TGSs established by the Survey of India is given in table 2.50 appendix 2.11(paragraph 2.345). Some other TGs are maintained by other organisations. Table 2.51 in appendix 2.11 paragraph 2.345 gives a list of such TGs in West Bengal. The TGSs are shown in fig. 2.46. The Committee felt that the number of TGSs available for Cyclone Warning is grossly inadequate. It recommended

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* IMDCP

CRC/45 : For the purpose of cyclone assessment and warning more TGSs have to be installed particularly in the river estuaries and littoral areas and specially in the island groups in the river delta regions as also in the areas notorious for cyclone landfalls.

2.81 ACCESSIBILITY TO THE TGSs :

The accessibility to these staions and communication between them and the ACWC/CWCs remain poor. The Committee recommended

CRC/46 : The intercommunication between the ACWC/CWCs and the Collecting Centres with the TGSs should be improved so that they function without fail during cyclone regimes.

2.82 PARAMETERS NEEDED TO BE MEASURED IN A CYCLONE BY A NEW GENERATION OF STORM SURGE GAUGES (SSGs) :

It is not sufficient that the highest water level of flooding mark is measured during a cyclone and that the instrument stand up to the fury of the rush of the surge following the storm. Some other parameters have now to be measured as required by new demands coming up. Because of offshore exploration of oil very expensive structures are being constructed on the continental shelf under the offshore waters costing crores of rupees. Very soon the engineers responsible for their design, construction and installation would need data on speed and pressure of water flow in storm surges usually faced in these regions so that they can ensure that these structures stand up to the fury of cyclones and the resulting surges. At present there are no instrumentation whatever at the TGSs to measure the velocities and pressures exerted by the storm surges excitedly. In summary a new generation of TGs are needed for cyclone management capable of measuring

1. Maximum tide level reached

2. Direction of the storm surge movement

3. Velocity of the storm surge rush

4. Pressures exerted by storm surges
5. Wave structures of the storm surge
6. Automatic timing of the above data recorded.

The Committee felt that instruments capable of such measurements should be designed/fabricated/installed at some selected places on an experimental basis. The Committee recommended

CRC/47 : The IMD should colaborate with the National Institute of Oceanography (NIO) to design/develop/fabricate a new generation of self recording storm surge gauges (SSGs) capable of measuring : (1) maximum storm tide level reached, (2) direction of storm surge movement, (3) velocity of storm surge rush, (4) pressure exerted by storm surge, (5) wave structure of the storm surge and (6) automatic timing of recording these data. The R&D should also involve the design/development/construction of structures on land/river/offshore sea, housing the SSGs capable of standing upto the violence of cyclone caused storm surges.

2.83 NEED FOR A CYCLONE STORM SURGE MONITORING AND FORECASTING ORGANISATION :

At present there are tide forecasting organisations under the Central Water Commission, the IMD which maintains Hydromet units on an agency basis in special catchment areas, some units under the Irrigation Departments of the State Governments and Port Trust bodies. The organisations of those forecasting units are discussed in detail in paragraph 2.103-2.104. Unfortunately from the point of view of the cyclone problem these units are most interested in precipitations over much wider areas/catchments river basin wise and not in the narrow regions of the CPARs. Thus there is need to set up a Cyclone Storm Surge Monitoring and Forecasting Organisation (CSSMFO) by the IMD. The actual storm surge warning to the public may be issued by the ACWC/CWCs, but the storm surge monitoring must be done by the Storm Surge Monitoring Centres (SSMCs) under the proposed CSSMFO. The Committee recommended :

CRC/48 : An important task of the ACWC/CWCs should be to collect and archive in a routine manner the data on storm surges for the areas under their control. A Cyclone Storm Surge Research Centre may be established within the IMD to assess/analyse these data on surges collected by the ACWC/CWC for research investigations with objectives to understand the storm surges and improve the techniques of their forecasting.

2.III.A(10) EXCHANGE OF INFORMATIONS WITH CYCLONE CENTRES IN NEIGHBOURING COUNTRIES

2.84 NEED TO ESTABLISH CLOSE COLLABORATION BETWEEN THE IMD AND THE CWCs OF THE NEIGHBOURING COUNTRIES :

The coasts of the Indian subcontinent lying in Pakistan, India, Shri Lanka, Bangla Desh and Burma are to different degrees vulnerable to visitations by cyclones. The work of cyclone monitoring and warning can be made easier if close Collaborationcan be established between the CWCs of these countries. The Committee was informed that the CWC in Bangla Desh was situated in Dacca with the CWRs at Dhaka, Khepupara and Cox Bazar. In Burma the CWR is located in Kyaukpyu and Pakistan has two at Karachi and Jiwani (appendix 2.6, paragraph 2.330, table 2.43). The Committee recommended :

CRC/49 : In the interest of better functioning of cyclones monitoring and warning systems established in India, it is desirable that close colaborations are established between the ACWC/CWCs of India and the CWCs of Bangladesh, Burma, Malaysia, Pakistan and Shri Lanka.

2.III.B. STATISTICAL DATA ON CYCLONES IN INDIA AND CLIMATOLOGY

2.85 PREPARATION AND PROCESSING OF VARIOUS TYPES OF STATISTICAL DATA AND INFORMATION ON INDIAN CYCLONES :

Cyclones in India have been under observation for over hundred years and a considerable body of statistics has accumulated. The this has been added the observations from Radars and Satellites over the past decade. The Committee appreciated the preparation by the IMD of the Cyclone Atlas covering cyclones in India over 100 years. The Committee felt that the accumulated statistical information should be similar processed. It therefore recommended :

CRC/50 : The frequency distribution of cyclone landfalls over coastal regions of India at 5 years interval should be periodically updated by the IMD.

CRC/51 : Statistics of the return period of cyclones over each coastal regions of India with an assessment of the vulnerability of these localities to cyclones should be prepared by the IMD.

CRC/52 : The Cyclone Atlas prepared by the IMD should be updated upto 1980 and may be widely circulated. It should show the tracks and include accounts of a selection of some particularly devastating cyclones occuring in India.

CRC/53 : The IMD should prepare an atlas of satellite imageries of Indian cyclones collected over the past decade and prepare individual analysis of structures/movements and classification of these cyclones based on their satellite pictures. This would provide materials for preparing cyclone models in developing theories of cyclone formation/evolution.

CRC/54 : The satellite pictures of Indian cyclones collected by the IMD should, in course of time, provide sufficient data to prepare a climatology based on the statistics of all cyclone eye formations in the Indian region, associated derived wind fields and pressure depths.

2.86 ARCHIVING INFORMATIONS ON INDIAN CYCLONES :

It was noted by the Committee that since 1960 when the satellites were first brought into use for monitoring/tracking cyclones, USA has microfilmed all satellite information of cyclones occuring round the world. The Committee recommended :

CRC/55 : The IMD should build up an archive of microfimed informations on cyclones over the Indian region based on the earlier studies of the Department, on current observations carried out through whatever techniques employed and the microfilmed satellite cyclone imageries collected by USA and other countries for the period from 1960 onwards. The archive should also contain the whole history/analysis of these cyclones and should be a reference centre for researchers on cyclones.

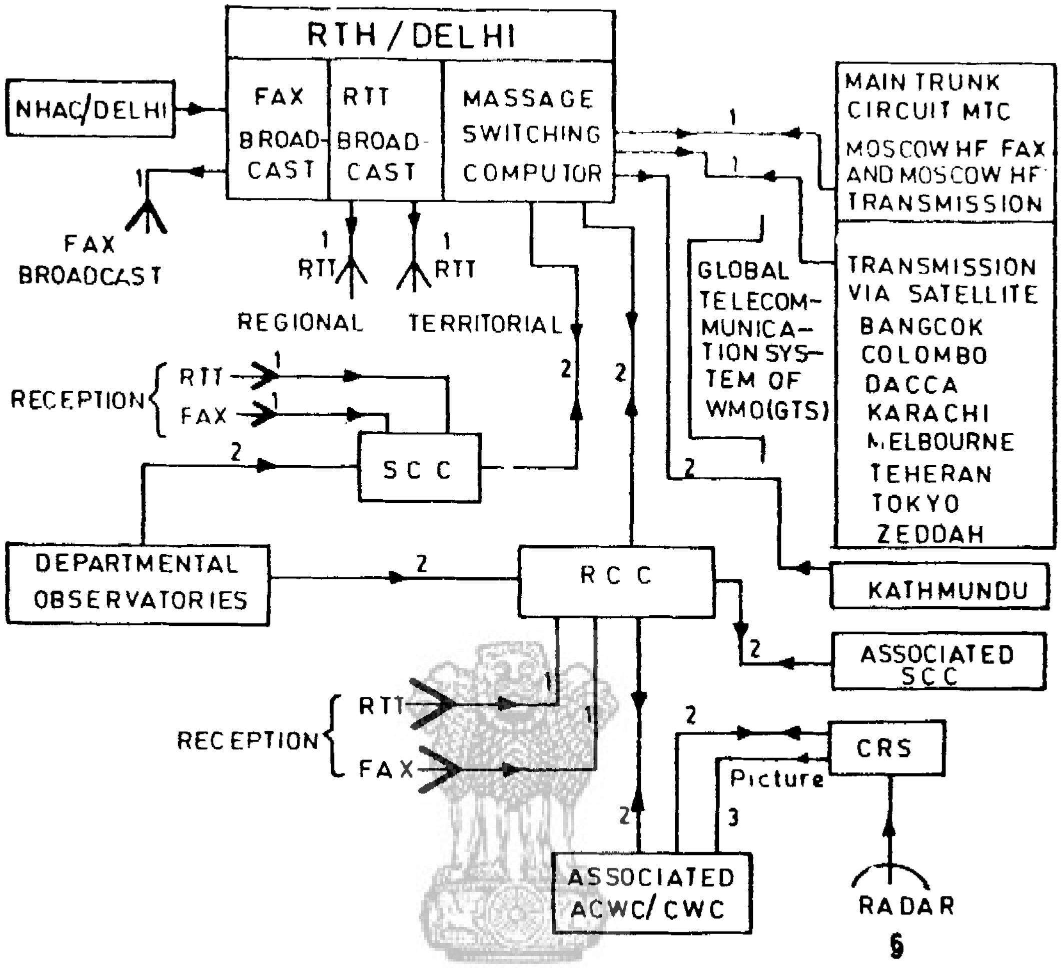
2.IV. THE CYCLONE WARNING SYSTEM (CWS) IN INDIA

2.IV.A DATA COLLECTION/ANALYSIS/FORECASTING CENTRES OF THE IMD FOR CYCLONES :

2.87 THE UNITS OF THE DATA COLLECTION SYSTEM OF THE IMD :

The units of the Data Collection System of the IMD on which cyclone assessment and various cyclone forecasting tasks assigned to the IMD are based, are :

1. Data Collecting Centres - Regional (RCC) and State (SCC)
2. Northern Hemisphere Analysis Centre (NHAC) at Delhi and Indian Ocean and Southern Hemisphere Analysis Centre (INOSHAC) at Pune
3. Weather Central at Pune (WC-Pune)
4. Regional Telecommunication Hub (RTH-Delhi)
5. Area Cyclone Warning Centres and Cyclone Warning Centres (ACWC/CWCs)
6. Automatic Picture Transmission (APT) Terminals described in paragraph 2.61 and Very High Resolution Radiometer (VHRR) terminals described in paragraph 2.67.
7. The Monitoring Stations - Surface and Upper Air Observatories (SO/UAOs), Cyclone Warning Radars (CWRs) and Tide Gauge Stations (TGSs)
8. The meteorological ground segment of the INSAT which is being set up consisting of Meteorological Data Utilisation Centre (MDUC) at Delhi and the Secondary Data Utilisation Centres (SDUCs).



LEGEND

1. Radio Broadcast Reception
2. Land line TP/Tellex/Telegram/Telephone/WT

   In case of failure of links 2 : Police W/T, Railway Microwave or Fixed Telecommunication Net Work of Civil Aviation Dept. may be available.
3. Proposed Picture Transmission

   FAX = Facsimile Transmission

   RTH = Radio Transmission Hub, NHAC = Northern Hemisphere Analysis Centre

   RCC = Regional Collection Centre

   SCC = State Collection Centre

   CWR = Cyclone Warning Radar

   ACWC/CWC = Area Cyclone Warning Centre/Cyclone Warning Centre

Fig.2.22 : Existing Data Collection System of IMD, Reference 38,39

The objectives and functions of these units will now be examined : The Data Collection System is schematically shown in fig. 2.22. The locations of the data collection centres are shown in fig. 2.21.

2.88 THE REGIONAL/STATE COLLECTING CENTRES (RCC/SCCs) :

In the national data collection system of the IMD there are 5 regional collecting centres which are connected to all State collecting centres. The collecting centres are listed below :

RCCs : 1. Bombay, 2. Calcutta, 3. Madras, 4. Nagpur, 5. New Delhi (Safdarjang-MO)

SCCs : (State Capitals) - 1. Agartala, 2. Ahmedabad, 3. Bangalore, 4. Bhopal, 5. Bhubaneswar, 6. Gauhati, 7. Lucknow, 8. Patna, 9. Srinagar, 10. Trivandrum, 11. Visakhapatnam.

A number of MOs are connected to the RCCs or to the SCCs. Weather data are collected by the RCCs and SCCs by land line Telegrams (LLTs), Teleprinters (TPs) or Wireless Telegraphy (WT) channels and transmitted to RTH which is equipped with a message switching system (MSS). Data received by the RTH from the different RCCs and from the Global Telecommunication System (GTS) are automatically routed to all the five RCCs, which in turn relay the data to the associated SCCs and to the ACWC/CWCs.

2.89 THE NORTHERN HEMISPHERE ANALYSIS CENTRE (NHAC) AT DELHI* :

Consequent on the establishment of the Northern Hemisphere Exchange Centre at Delhi which was member of a chain of such centres - Delhi, Frankfurt, Moscow, New York, Tokyo, set up under the auspices of WMO for expeditious collection/ distribution of meteorological data daily round the clock in the Northern Hemisphere, a Norther Hemisphere Analysis Centre (NHAC) was set up at Delhi in 1962 with limited functions and responsibilities to begin with - mainly to utilise the large volume of hemispherical data collected for improving the forecast accuracies for national/international user interests, including those of long distance high level jet aircraft operators. This centre was later expanded to take over the responsibilities of the Regional Meteorological Centre (RMC) and Area Forecast Centre (AFC) under World Weather Watch (WWW) scheme of the WMO. At present NHAC is a very important data analysis centre for correlating all the data collected from Northern hemisphere. The NHAC maintains a 24 hr watch daily on the Indian weather. The takes of NHAC are :

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* IMD Cyclone Manual - Chapter 1
IMD Standard Brief 1983

1. Coordinating storm/cyclone warning work at the headquarters of the IMD,
2. Issuing a numbered bulletins to AIR - New Delhi,
3. Issuing of storm surge advisories to the ACWC/CWCs,
4. Dealing with the Government of India, the coastal State Governments and various agencies on matter related to storm/cyclone warnings and cyclone distress mitigation work and
5. Participating in the activities of various international bodies like World Meteorological Organisation (WMO) and Economic and Social Commission for Asia and Pacific (ESCA).

It will be seen that NHAC-Delhi duplicates some of the work done on cyclone assessment at WC-Pune (paragraph 2.91). The Committee felt that since there is a large concentration of major facilities at the IMD Headquarters at Delhi for Cyclone watching, it is advisable to have the cyclone assessment work done at the NHAC-Delhi and not at WC-Pune as at present. Further it is seen that NHAC-Delhi has already been assigned the responsibility of advising on long term measures for a Community Preparedness Plan for cyclones and on cyclone mitigation measures. The Committee felt that this organisation should also advise on the formulation of cyclone codes and their updating in the light of experience gathered. The Committee recommended :

CRC/56 : Since the NHAC-Delhi receives all meteorological data from all Indian collecting centres and the ACWC/CWCs, the analysis of the data for cyclone assessment should be concentrated at this centre only. For this purpose it is necessary to ensure that all informations regarding cyclones from the Coastal Meteorological Observatories/Island Meteorological Observatories (CMO/IMOs), SO/UAOs, ships, DCPs, CWRs and the satellites are promptly received at the NHAC on real time through the existing Message Switching Computer installed there. The NHAC should also have a computer of large storage capacity where all those messages can be stored and the instantly available, processed in any format desired by the cyclone analyst whenever needed for assessment purposes.

CRC/57 : The IMD should advise the Apex Cyclone Committee (ACC) on various technical aspects of long term measures for preparing the community for cyclones. It should also advise the ACC on the formulation of cyclone codes (CCs) for the coastal states and their updating in the light of gathering experience.

2.90 THE METEOROLOGICAL PRODUCTS PREPARED AT THE NHAC* :

Many products are prepared at the NHAC from the data collected from the Northern Hemisphere which are of great assistance to forecasters. Some of the computer products prepared by the NHAC are :

1. Storm analogy forecasts
2. Storm surge forecasts
3. vertical divergence/motion
4. monthly/weekly mean sea surface temperature charts
5. zonal index charts
6. diagnostic charts
7. mean contour charts

All these are of great importance to the forecaster in the assessment of the weather system and associated weather. Much work has been done at this centre on the development of various phases of numerical weather prediction (NWP) models and there has been considerable progress in data automation and objective analysis. In course of time it is hoped that much of the manual work necessary for the output of the required processed products will be replaced by computer made products. But it has been the experience also that for long term forecasts human intervention is necessary at various stages so that a man-machine mixed forecasting system cannot be avoided.

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* CMAS : Notes on Agenda.

2.91 WEATHER CENTRAL (WC) AT PUNE* :

The Cyclone Warning work is coordinated by the Deputy Director General of Meteorology (DDGM). The cyclone forecast is disseminated through the Weather Central (WC) at Pune. Pune-WC keeps a continuous watch over the weather over the whole country for

1. effectively appreciating weather evaluation,
2. advising and guiding the ACWC/CWCs and other forecasting centres,
3. exercising general technical control and supervision over all the forecasting centres,
4. take necessary steps for continued improvement and efficiency of the cyclone warning system of the country as a whole.

WC-Pune is either directly linked to the ACWC/CWC or through the Message Switching (MS) computer at the RTH. The organisation of the Cyclone Warning System (CWS) is therefore in two tiers - the supervision is done by the DDGM(WF) at WC-Pune and the actual operational work done by the ACWC/CWCs for their respective areas of responsibility. WC-Pune extends its watch hours round the clock when the weather bulletins received from the ACWC/CWCs have to be edited for passing on to the NHAC for onward transmission to the AIR for broadcast as numbered bulletins in the News Cycle.

2.92 NEED FOR A CYCLONE ASSESSMENT CELL (CAC) :

In paragraph 2.89 the Committee recommended that all cyclone assessment should be done at NHAC-Delhi (Recommendation CRC/56). For this purpose the Committee further recommended :

CRC/58 : The IMD should set up a Cyclone Assessment Cell (CAC) at Delhi dedicated to coordinating and evaluating the incoming data from the ACWC/CWCs and the Regional/State Collecting Centres (RCC/SCCs) and aother data centres.

2.93 INDIAN OCEAN AND THE SOUTHERN HEMISPHERE ANALYSIS CENTRE (INOSHAC) AT PUNE :

Analysis of weather in the region of India Ocean and the Southern Hemisphere is done at the INOSHAC at Pune.

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* Cyclone Manual - Chapter 1

Of special interest for the CWC is the forecast that is made for the ships on high seas. These forecasts are sent to Bombay-MCC. (Meteorological Communication Centre).

2.94 THE APT/VHRR TERMINALS :

The APT stations and the locations of VHRR terminals for satellite imageries have been described in paragraphs 2.61, 2.67 and 2.69. The recommendation for the improvement of the quality of the APT pictures is given in CRC/25, 26, 27. The recommendations relating to the VHRR terminals are given in CRC/28, 29.

2.95 THE METEOROLOGICAL DATA UTILISATION CENTRE (MDUC) AT DELHI AND THE SECONDARY DATA UTILISATION CENTRES (SDUCs) :

The role of the MDUC vis a vis the INSAT system has been already described in paragraph 2.70 together with the details of processing of the VHRR/DCP data received via INSAT at this centre. The special products prepared from the processed data issued by this centre has also been described. The VHRR cloud imagery data and other meteorological observations taken from INSAT are to be received at the P&T Delhi Earth Station (DES) located at Secunderabad. The data is then transferred to the MDUC by a microwave channel (paragraph 2.70) on real time. The first INSAT meteorological data was transmitted by these links on 25.5.1982. The Secondary Data Utilisation Centres (SDUCs), located at the various forecasting centres of the IMD (table 2.44 appendix 2.7 paragraph 2.334) received from the MDUC over the IMD land based TC circuits and the INSAT circuits which are considered in paragraph 2.110-2.114. Presumably some of the SDUCs will be located at the ACWC/CWCs also. TP circuits between MDUC and Master Control Facility (MCF) at Hassan and Network Operation and Control Centre (NOCC) at Secunderabad have already been established. Since it is remembered that all cyclones informations should be correlated/integrated at Delhi the Committee further recommended :

CRC/59 : All the INSAT meteorological data processed at the Meteorological Data Utilisation Centre (MDUC) at Delhi should be transferred to all the Secondary Data Utilisation Centres (SDUCs) particularly to those situated at the ACWC/CWCs.

2.96 THE CYCLONE WARNING CENTRES (ACWC/CWCs) AND THEIR AREAS OF RESPONSIBILITY* :

The heart of the Cyclone Warning System (CWS) for each region lies in the Cyclone Warning Centre (CWC) or the Area Cyclone Warning Centre (ACWC) of that region. At present the IMD has three ACWCs at Bombay, Calcutta and Madras and two CWCs at Bhubaneswar and Visakhapatnam, each with its area of responsibility which are given in table 2.11.

TABLE 2.11

AREAS OF RESPONSIBILITIES OF THE AREA CYCLONE WARNING CENTRE/CYCLONE CENTRES (ACWC/CWCs)

ACWC/CWC	Area of responsibility
1. Bombay - ACWC	Arabian Sea, Maharashtra, Goa, Daman, Diu, Gujarat and the sea off these states
2. Calcutta - ACWC	Bay of Bengal, including Andaman and Nicobar islands, West Bengal and the adjoining areas of West Bengal coast
3. Madras - ACWC	Tamil Nadu, Pondicherry, Kerala, Karnataka, the sea of these states up to 80 km and Lakshadwip
4. Bhubaneswar - CWC	Orissa and the sea off Orissa coast upto 80 km
5. Visakhapatnam - CWC	Andhra Pradesh and the sea of Andhra Pradesh coast upto 80 km.

The storm warning of centre at Calcutta is the oldest, having been established in 1865. The present ACWC-Calcutta is located at Alipore. The ACWC at Bombay was established in Colaba in 1956, and that in Madras in Nungambakkam in 1969. The CWC at Bhubaneswar was established at the Bhubaneswar Airport in 1973 and that at Visakhapatnam in 1974. The CWC-Bhubaneswar is under the general control of the ACWC-Madras. MO-Hyderabad liases between CWC-Visakhapatnam and Government of Andhra Pradesh at the State Capital for warnings, briefings and advisories.

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* IMD Cyclone Manual : Chapter 1 (1980)

2.97 NEED TO ESTABLISH A FEW MORE ACWC/CWCs :

The east coast seems satisfactority covered by ACWC/CWCs except that the long Andhra Pradesh coast may be better served by another CWC to operate CWS in the southern portion of this state. The Andaman and Nicobar Islands may usefully have a CWC to warn the ships plying in the middle regions of the Bay of Bengal. The west coast has only one ACWC located at Bombay, and the responsibility is shared by ACWC-Madras. Another CWC may be required at Ahmedabad for operating the CWS in Gujarat and the sea off this state. The responsibility of the ACWC-Madras for Karnataka and the sea off this state may be transferred to the Bombay-ACWC. The Committee recommended :

CRC/60 : A Cyclone Warning Centre (CWC) may be established at Ahmedabad for more effectively operating the Cyclone Warning System (CWS) on the west coast of India.

2.98 RESPONSIBILITIES/TASKS OF THE ACWC/CWCs :

The main task and responsibility of the ACWC/CWCs is to issue area bulletins, coastal weather advisories, port warnings, fisheries warnings, cyclone bulletins, cyclone warning messages (CWMs), general directives, advisories and informatory messages to designated officials of the State, Album page warnees, ships coastal and on the high seas and to the general public - to each group of warness according to its special interests and needs. The different categories of warnees will be discussed in paragraph 2.140. The CWMs will be discussed in paragraphs 2.145-2.155. The ACWC/CWCs have the further responsibility to issue routine weather forecasts and warning for benefits of farmers and fishermen two or three times a day. The ultimate responsibility for operational cyclone warning work for the respective areas rests with the ACWC/CWCs. Specifically the ACWC/CWCs issue for their respective areas the following bulletins and warnings :

1. Weather and sea area bulletins for (a) shipping on high seas and (b) ships plying in coastal waters.
2. Coastal bulletins, Fleet forecast bulletins for the Indian Navy - issued by ACWCs-Bombay and Calcutta only.
3. Bulletins for departmental exchanges - issued by ACWCs-Bombay, Calcutta and Madras.
4. Port warnings.
5. Fisheries warnings.
6. Two stage cyclone warnings.
7. Bulletins for the AIR - (a) Special weather bulletins and (b) Coastal bulletins for the AIR New Cycle.
8. Album page warnees.
9. Bulletins for the Press.
10. Aviation warnings - issued by concerned Aviation Meteorological Office.

The CWCs issue the bulletins and warnings on the basis of the sea area bulletins from their parent ACWCs. However when a cyclone comes with the range of CWRs at Paradip or Dolphin's Nose and the Radars are able to track it with accuracy and confidence, then the CWCs may issue the warnings on their own without waiting for the bulletins from their parent ACWCs. Moreover CWCs can act on their own whenever communications with the parent ACWCs break down.

2.99 ISSUANCE OF CYCLONE WARNINGS/BULLETINS BY THE ACWC/CWCs* :

Round the clock weather watch is not normally kept at the ACWC/CWCs. Watch is normally kept over a period of 18 hrs from 0600 hrs IST to 2400 hrs IST resulting in a morning and an evening chart. Forecasts based on the morning chart is made at noon and those based on the evening chart during early night. In addition forecasts are also made as required for special category of warnees. When the weather disturbances are in mild stages additional forecasts/warnings based on additional midnight charts are made for the benefit of coastal shipping and ships on high seas and for port authorities. When the weather disturbance passes from the depression stage to the storm/severe cyclone stage, weather watch is kept and weather charts are made round the clock. When the cyclone is within the CRH and is being tracked, cyclone bulletins are issued round the clock. Not only are the frequencies of the warnings increased but the categories of warnees are also increased and the CWMs are made more specific and concrete to serve their special needs and interests. There is a standing order that when there is unexpected and rapid development and the watch period of the ACWC/CWC is observed not to be promptly extended, the associated Airport Meteorological Office where a 24 hrs watch is always maintained, can promptly bring such developments to the notice of the Storm Warning Officer in charge by telephone for further action.

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* IMDCP

2.100 NEED FOR ROUND THE CLOCK WEATHER WATCH BY THE ACWC/CWCs:

It has been stated in paragraph 2.17 that the cyclone season in India has a duration of 7 months and during this time ACWC/CWCs are expected to be quite busy. Since there are other forecasting responsibilities besides those connected with cyclones given to the ACWC/CWCs, a case has been made for round the clock weather monitoring all through the year to cover sudden weather changes between midnight and early morning. The Committee however makes no specific recommendation on this point.

2.101 WORKING CONDITION FOR THE STAFF OF THE ACWC/CWCs :

During a cyclone regime, communication with the ACWC/CWCs are liable to be snapped. It may often be necessary for the personnel manning these centres to work beyond duty hours. This requirement gives rise to a number of logistic and administrative problems which have to be solved. The Committee recommended :

CRC/61 : Officers and other cadres working in ACWC/CWCs should be provided quarters within the premises of these centres. Questions of work leave, building up of reserve personnel and improvements of working conditions of the staff should be considered so as to minimise the fatigue of long hours of work. The consequent administrative problems arising should be solved by the IMD. Similar facilities may be provided to officials of other government agencies/departments involved in CMS/CWS.

CRC/62 : As the tasks/responsibilities of the ACWC/CWCs are steadily rising, it is necessary to change the staffing pattern at these centres so as to strengthen the staff there and reduce the heavy pressure of work that has to be met.

2.102 NEED FOR INSTALLING MINICOMPUTERS AT THE ACWC/CWCs :

The Committee considered the data handling capabilities of the ACWC/CWCs. It was noted that the input data from the CMO/IMOs of various types during the cyclone season is likely to be very large. These data have to be sorted, stored and retrieved, and also processed for analysis and assessment for the purpose of warnings which are to be given in standard formats. The time available for all this work for a particular cyclone is usually very limited before it makes its landfall. Therefore there is a large possibility of loss of vital informations required for the CWMs. As the ultimate responsibility for the cyclone warning rests with the concerned ACWC/CWC only, it is necessary to strengthen the computation capability of these centres. The Committee recommended :

CRC/63 : Each ACWC/CWC should be equipped with a suitable minicomputer to process the incoming data on cyclones from the CMO/IMOs for transmission to the CAC at Delhi. The minicomputer should also have automatic data message handling capabilities, large storing facility and the peripherals for immediate display/print outs as required.

2.103 FLOOD FORECASTING ORGANISATIONS IN INDIA* :

In earlier times the Central Water Commission (CWC) had set up Flood Forecasting Divisions (FFDs) under it in different states, and had installed a large net work of rain gauges (RGs) in important catchment areas of major river besins and areas of large water resorvoirs for flood forecasting. The Irrigation department of many states also set up similar net work of RGs. In 1963 the Government of India appointed a Committee on scientific flood forecasting. Particular emphasis was laid on the need for an adequate meteorological organisation to backup the country's flood forecasting services. The Ministry of Irrigation and Power set up in 1970 a Committee of Ministers which reiterated this need. Accordingly in 1972 a scheme is launched under the 4th Five Year Plan to set up a Flood Meteorological Organisation (FMO) in the IMD. At present the FMOG of the IMD consists of

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* IMD Standard Brief (1983)
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1. The headquarters organisation in Delhi
2. Flood Meteorological Offices (FMOs) at Ahmedabad, Asansol, Bhubaneswar, Delhi, Gauhati, Hyderabad, Jalpaiguri, Lucknow and Patna.
3. Instrument manufacturing unit at Pune.

The functions of the headquarter Delhi are

1. to maintain close liaison with the Central Water Commission (CWCM) to meet its requirements and to ensure the maximum meteorological support,
2. to coordinate the activities of the FMOs,
3. to render technical assistance to the FMOs,
4. to plan the net work of additional ordinary/ self recording RGs to be installed,
5. organise occasional FM seminars.

It is proposed that a Directorate of Flood Forecasting be established at Delhi by the IMD. The function of the FMO is to render meteorological support to the Water Resources Divisions (WRDs) and Flood Forecasting Division (FFD) of the CWC. The FMO, WRD and FFD are all located at the same place except for Ahmedabad. The WRD/FFD at Gandhinagar and Surat are meteorologically supported by FMO-Ahmedabad. Synoptic charts prepared at the Meteorological Centres (MCs) are generally used at the FMOs. The work done by the FMOs during the flood season :

1. Maintenance of 12 hr flood meteorological watch throughout the season and during the flood alert period round the clock.

2. Supply of rainfall data to WRD/FFD of the CWC
3. Supply of information on the synoptic situation and other weather informations relevant to river level forecasting
4. Issue of quantitative precipitation forecast (QPF) on semi-emphirical basis to the FFDs for periods of 24-28 hrs in advance
5. Provide weighted average of the rainfall (WAR) in the catchment areas basin/sub-basin wise for duration of 24 hrs or less
6. Issue of heavy rainfall warning, when warranted, so that flood alert is possible at least 48 hrs ahead
7. Preparation and supply of weekly flood reports to FFDs/HQ office
8. Attending to defects in the reporting RGs at field units.

During the nonflood season the function of the FMOs are :

1. Preparation of season flood reports
2. Inspection/installation of the RGs
3. Soutiny of the self recording rain gauge (SSRG) charts and processing rainfall data
4. Computation of antecedent precipitation index (API)
5. Make network density studies for determination of representative network in the catchment
6. Write up the basin meteorology
7. Prepare flood albums
8. Carry out studies for development of techniques of QPF suited in each area
9. Make Hydrometeorological analysis for tide/storm surge

10. Undertake investigational problems useful to issue of forecasts/flood warnings

The location of the FMOs in the coastal states which may be used for cyclone forecasting purposes is given in the appendix 2.10 paragraph 2.343, table 2.48. The ordinary/ self-recording RGs (ORGs/SRGs) required for new installation/ replacement under the jurisdiction of the FMOs are being met by the Instrument Division at Pune. Hydrometeorological Observatories (HMOs) have been set up by the CWCM/State Government/Railways/Forest Departments/IMD in connection with flood forecasting in river basin studies/compilation of rainfall statistics for use in construction of dams railways and road bridges/snowmelt in rivers and water balance and glacialogical studies. These centres are of vital importance for management of large water reservoirs or water flooding. The departmental HMOs of the IMD take rainfall observations twice daily. There are also non-departmental HMOs of the IMD which take observations once daily. The IMD often undertake this work in limited regions on an agency basis. The IMD has three such units in the coastal states : (1) one is the hydromet unit for the Godavari basin established in 1978 at Colaba-Bombay, (2) the seond hydromet unit is at Calcutta for the Damodar Valley and (3) the third hydromet unit is at the FMO-Bhubaneswar for the Mahanadi catchment. It is now proposed to set up a Flood Forecasting Organisation (FFO) directorate.

2.104 SUGGESTED IMPROVEMENTS IN THE FLOOD METEOROLOGICAL OFFICES (FMOs)* :

Under the project - Improvement/modernisation of the FFOs, the following programme inter alia was suggested :

1. Augmentation of the RG network and precipitation studies : The final number will be finalised after consultation with the FMOs. It is proposed that 100 ordinary/100 self recording RGS will be installed during the Plan period. It is also proposed to undertake a small project to undertake precipitation studies in selected catchment areas.

2. Provision of WT/RG stations at selected places : The normal method of transmitting RG data is by land line telegrams (LLTs). The link frequently breaks down during flash floods/cyclones/

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* CMAS : Notes on Agenda

storm surges. It has therefore been proposed that the Central Water Commission (CWCM) opens a number of WT stations along river catchments. For making QPPs the IMD proposes to set WT arrangements where LL links are either not satisfactory or a CWCM-WT or a State Government WT/HF/UHF net work do not exist. In Orissa there are three such locations : Chandbali, Hirakud and Phulbani.

3. Provision for computer facility at Damodar Valley Corporation(DVC) - Meteorological Unit and all the FMOs : Complex computation have to be done like rainfall run off, estimation of area wise rainfall, modelling of hydrometeorological components determining catchment behaviour etc. For the FMOs to be able to make their forecasts. For this purpose it is proposed to have this computer facility. Installation of such a facility would greatly help compilation of spatial extents of flooding caused by depressions/cyclones in Orissa and West Bengal. It is also proposed to instal microcomputers at all the FMOs which would not only add to their forecasting capabilities but also to their ability to handle problems for management of water reservoirs - hydrodams/lakes/tanks flooding over embankments etc.

4. Augmentation of the FMO-Ahmedabad to meet the needs of FFD-Surat and FFD-Gandhinagar of CWC.

5. Setting up of Limited Data Centre at Delhi as a part of the Hydromet National Reference Centre (HNRC) of the CWC under the Hydrological Operational Multipurpose Subprogramme (HOMS) of the WMO : In the HOMS programme the CWC is the nodal department. The objectives of the HOMS programme are : hydrological data collection/storage/retrieval/data aprocessing for planning/design/operation of water resources projects/flood forecasting. For implementation of HOMS as well as to provide informations to several institutions engaged in hydrological studies it has been proposed to establish a HOMS National Reference Centre (HNRC). While CWC is involved with surface waters only, IMD is concerned with all hydrometeorological data available now on such data collection systems as satellites. IMD is proposing to establish a Limited Data Centre in respect of all hydrometeorological data at Hydromet Directorate at Delhi.

6. Strengthening of the FMOs.

The Committee considers all these measures important which merit expeditious implementation. The Committee did not make any specific recommendations on this matter.

2.IV.B CYCLONE DATA COLLECTION/DISSEMINATION/ WARNING SYSTEMS (CDCS/CDDS/CWSs)

2.IV.B(1) CENTRE FOR COLLECTION/DISSEMINATION OF NATIONAL/INTERNATIONAL METEOROLOGICAL DATA

2.105 THE REGIONAL TELECOMMUNICATION HUB (RTH) AT DELHI*:

Under the Global Telecommunication System (GTS) organised as part of the World Weather Watch (WWW) Plan, the Regional Telecommunication Hub (RTH) has been established at Delhi on the Main Trunk Circuit (MTC) connecting three World Meteorological Centres at Moscow, Melbourne and Washington. This automated centre of the IMD for collecting weather informations from the global scene is the principal telecommunication centre in South Asia and its zone of responsibility extends roughly from Saudi Arabia in the west to Thailand in the east. RTH collects data from this area for feeding the global telecommunication system for global exchange. It receives meteorological data from different circuits connected to it and arrange for their relay. The meteorological data reach the RTH within 2 hours of the observations being taken. Other meterological services in the Middle East and South East Asia also depend for their data requirement on the RTH. This has the following interconnections given in table 2.12

Working Paper 21 placed before the Committee by IMD.

TABLE 2.12

TELECOMMUNICATION CHANNELS (TCCs) AT RTH-DELHI

Type of TC Linkage	Interconnections	Message carrying capacity in bauds/ FAX data channel
I. HF line	1.Delhi-Moscow	1200 bauds (proposed to be upgraded to 2400 baud)
	2.Delhi-Moscow	Facsimile (FAX)
II. Via Satellite	3.Delhi-Bangkok	50 baud
	4.Delhi Cairo	50 baud
	5.Delhi-Colombo	25 baud
	6.Delhi-Dhaka	50 baud
	7.Delhi-Jeddah	75 baud
	8.Delhi-Karachi	50 baud
	9.Delhi-Melbourne	75 baud
	10.Delhi-Teheran	50 baud
	11.Delhi-Tokyo	2400 baud
III. Landline TP	12.Delhi-Kathmandu	50 baud

The name baud of the unit of data transmission is derived after Baudecot the name of the code which the teleprinters use. It is actually the same as bps (bits per second). In the National Data Collection System, the RTH is connected by TP network to the RCCs which are in turn connected also by TP links to the 11 SCCs.

2.106 BROADCASTS BY RTH* :

One of the tasks of the NHAC is to process all the weather informations received at RTH, process them and prepare charts containing the analysis and the prognosis. The area covered by these charts are : (1) 45°N - 25°S x 30°E - 125°E and (2) 0°N - 40°N x 30 E - 125°E. The RTH has another important function besides receiving weather informations from international and national sources and relaying them to the RCC/SCC/ACWC/CWCs. The RTH operates 2 RTT (Radio Tele Type) - Regional and Territorial and FAX broadcasts at various frequencies in the MF range. The broadcasts are audible over a radius of 600 km round Delhi and are regularly received in Africa, Asia, Australia and Europe. The 30 KW FAX broadcasts are received in Africa, Asia, Australia and Europe. There is also a FAX channel (Table 2.12) between New Delhi and Moscow for exchange of analysed and prognostic weather charts and satellite pictures. The details of RTH broadcasts are given in table 2.13. Further details are given in appendix 2.12, tables 2.52, 2.53,(paragraph 2.347).

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* Working Paper 21 placed before the Committee by IMD: Weather Service to Shipping. Fishing Vessels and Marine Interests : IMD (Correction Slip No.3) (1974)

TABLE 2.13

BROADCASTS BY RTH

Types	Transmission	Contents of Transmission
1. RTT broadcast (Regional RTT)	Three P&T 5 KW transmitters	Weather data from basic stations in countries in Middle East - South East Asia
2. NTT broadcast (Territorial-RTT)	5 KW P&T transmitter and 10 KW Overseas Communication Services (OCS) transmitter	National data from selected Indian Stations
3. FAX broadcast	20 KW transmitter(three frequencies) and 30 KW OCS transmitter(one frequency)	Processed, analysed and prognostic information in chart forms containing analysis from NHAC

2.107 AUTOMATION AT RTH* :

Since the RTH has to handle high speed global exchange of meteorological data round the clock between the

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* IMD CMAS : Notes on the Agenda.

Regional Meteorological Centres (RMCs) through the MTC and its branches of the GTS, the centre has been fully automated by the installation of a computer, the message switching system (MSS), which can work at a speed ranging upto 9600 bauds. The connectibility of the present MSC is to 51 circuits only including service lines to computers. Out of these only two can be operated on medium speed - 2400 bauds. The useful life of this MSC is estimated to come to an end in 1982-83. This MSS system DS714 was obtained as a gift from Netherlands in 1975 under the Voluntary Aid Programme (VAP) of the WMO under the WWW project. For the operation of 1200 baud New Delhi - Moscow circuit on HF an equipment known as LUCH offered by USSR is in use.

2.108 PROPOSED FOR IMPROVEMENT OF THE FACILITIES AT THE RTH :

It has proposed that to improve the capability of data collection/exchange via the RTH the following actions should be taken :

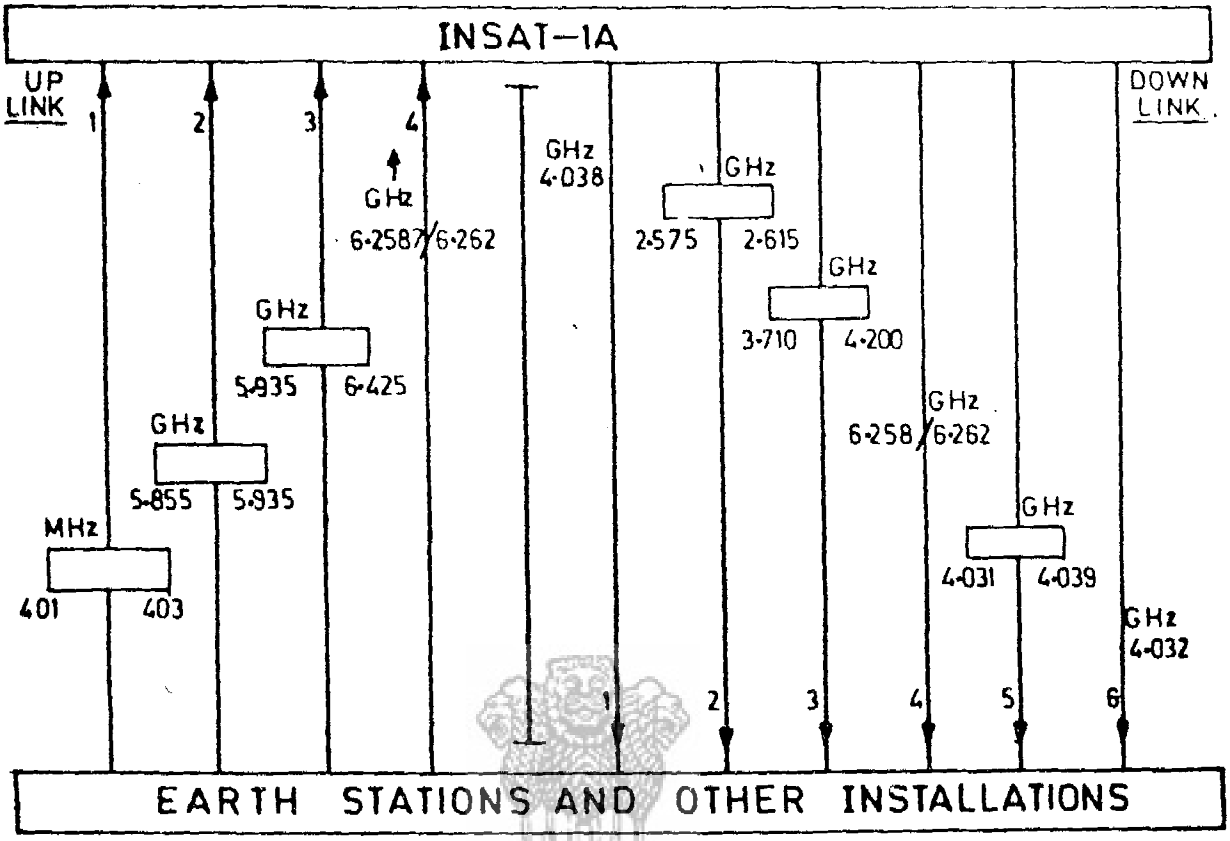
1. To hire suitable TP channels from the P&T Department to increase the speed of circuits with the Airport Meteorological offices to 200 bauds. At present low speed TP channels - 50 bauds are used which result in considerable delay in the availability of data at the Airport Meteorological offices and the transmission loses much of its importance for effective importance utilisation of the data for operational needs.

2. To enable efficient functioning of automated telecommunication centre at Delhi as part of the International obligation of the IMD and also provide for national exchange of meteorological data the existing MSS at RTH may be replaced by a new and more advanced system to meet the future needs.

3. To instal MSSs at the Airport Meteorological offices.

2.109 FACILITIES AT COLLECTING CENTRES TO RECEIVE BROADCASTS FROM RTH- DELHI :

All the RCCs and SCCs have facilities for receiving the RTT and FAX broadcasts from RTH. Visakhapatnam CWC does



Legend

1. Meteorological/DCP
   Uplink : 402.75 MHz/200 kHz BW,
   Downlink : 4.038 GHz/0.1 MHz BW
2. Direct TV/Radio/Disaster Warning :
   Uplinks : 2 channels/36 MHz BW, Frequencies : 5.875, 5.915 GHz
   Downlinks : 2 channels/36 MHz BW, Frequencies : 2.575, 2.615 GHz
3. Telecommunication/TV/Telephony
   Uplinks : 12 channels/36 MHz, Frequencies : 5.955, 5.995, 6.035, 6.075, 6.115, 6.155, 6.195, 6.235, 6.285, 6.325, 6.365, 6.405 GHz
   Downlinks : 12 channels/36 MHz, Frequencies : 3.730, 3.770, 3.810, 3.850, 3.890, 3.930, 3.970, 4.010, 4.060, 4.100, 4.140, 4.180 GHz
4. Command : Uplink and Downlink 2 channels 6.258, 6.262 GHz
5. Telemetry : Downlink : 2 channels, Frequencies : 4.031, 4.039 GHz
6. VHRR : Downlink : Frequency : 4.034 GHz
7. Broadcast : Downlink : 2.575, 2.615 GHz

Fig.2.23 The INSAT-1 frequency plan. Reference 67

not have yet these facilities. Not all the ACWC/CWCs have both the facilities as will be seen from table 2.20 (paragraph 2.126). The Committee recommended :

CRC/64 : All the ACWC/CWCs should be equipeed with RTT systems and facilities for receiving FAX broadcasts from the Regional Telecommunication Hub (RTH)-Delhi.

2.IV.B(2) DATA COLLECTION/COMMUNICATION VIA THE INSAT-1 AND THE DCPs

2.110 DATA COLLECTION/COMMUNICATION VIA THE INSAT-1 AND THE DCPs :

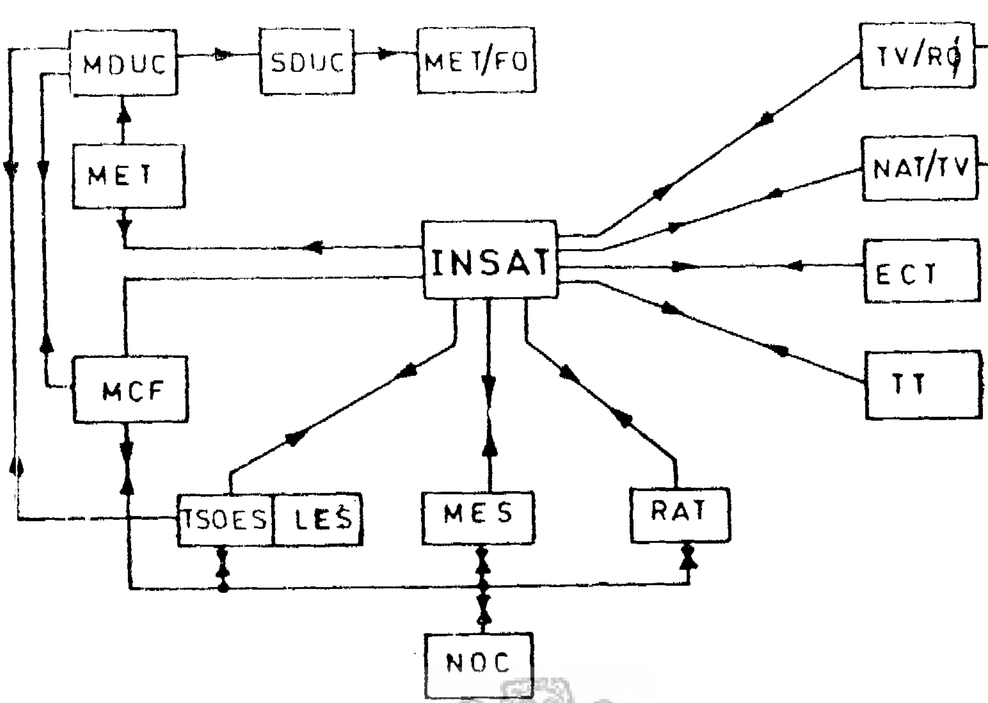
It is proposed that collection of data from the DCPs on land and sea will be done via INSAT S-band facility. This is discussed in paragraph 2.113. The TC capabilities with INSAT are also discussed in paragraph 2.113.

2.111 THE TC SYSTEM SUGGESTED BY THE SPACE APPLICATION CENTRE (SAC) FOR INSAT-1 SYSTEM :

The recommendation for improvement of APT reception has been given in 2.61 (Recommendation CRC/25 & 26). The Space Application Centre (SAC) of the Indian Space Research Organisation (ISRO) has suggested a TC interlink with the meteorological centres which should be of great value in the matter of cyclone warning. As warned in paragraph 2.120, TC facilities aboard the satellites have been known to fail and there are no remedial measures possible. Thus the INSAT TC system should be considered to be an additional information collection/dissemination system which may take precedence over the other TCs because of its speed and immunity from any interference whatever, when the system works. The TC system proposed to outlined below with some changes of nomenclatures of the stations made in view of subsequent development. Thus

National Meteorological Centre (SAC) = MDUC-Delhi/RTH-Delhi/ Pune-WC,

Regional Meteorological Centre (SAC) = ACWC/CWC



MCF ≡ Master Control Facility (at Hasan) : 1. On orbit control of Satellite, 2.Health Monitoring of Satellite, 3.Orbit raising control

TSOES ≡ Turn Satellite Operation Earth Station

LES ≡ Large Earth Station : 1.Intermain and main trunk telephony, 2.Remote area communication, 3.TV uplink for feeding TV channels, 4.Reception of meteorological data from Satellite (at LES-New Delhi)

MES ≡ Medium Earth Station : 1.Trunk telephony (main primary), 2.TV uplink feed

NOCC ≡ Network Operation Control Centre (at Delhi)

RAT ≡ Remote Area Terminals : Telephony only

ECT ≡ Emergency Communication Terminal : Jeep transportable and air liftable for meeting short notice emergency requirements

TV-RC ≡ Direct TV broadcast to rural community

NAT-TV ≡ Rediffusion of Satellite TV by terrestrial transmitters - National network

TT ≡ Transportable Terminals

MET ≡ Meteorological observation centres including DCPs and relay platforms

MDUC ≡ Meteorological Data Utilisation Centre (Delhi)

SDUC ≡ Secondary Data Utilisation Centre (Delhi)

MET/FO ≡ Meteorological Forecast Offices including ACWC/CWCs

Fig.2.24 : INSAT network, Reference 68

In the proposed TC system for INSAT the channels contemplated are given in table 2.14 :

TABLE 2.14

TCC PROPOSED FOR INSAT BY ISRO

Ground Stations Linked	Types of Link	Purpose
1. MDUC-Delhi/ RTH/Pune-WC to ACWC/CWC	Two way	Exchange of weather information special instruction
2. ACWC/CWC to CMOs (in cyclone affected region)	Broadcast mode for inter-connecting TP and for providing voice link	The voice link is meant for broadcast of special instructions, messages etc. from ACWC/ CWC to CMOs
3. ACWC/CWC to CMOs	Two way communication link	For transferring weather data from CMOs to ACWC/ CWCs
4. Pune-WC to ACWC/CWC & CMOs	A broadcast channel supporting a voice link and a TP link	For broadcast of warning special instructions etc. from Pune-WC to any or all of the ACWC/CWCs and the CMOs
5. Pune-WC to ACWC/CWCs, CMOs and ships on sea	A broadcast link for issuance of warning in case of extreme emergencies	

2.112 PLAN FOR REALISATION OF THE TC SYSTEMS FOR INSAT 1-A PROPOSED BY SAC :

It was planned that all the TCCs proposed in Table 2.14 can be realised as summarised in Table 2.15

TABLE 2.15

PROPOSAL FOR REALISATION OF TCCs CONTEMPLATED FOR INSAT UTILISATION

Type of TCC	Realisation
1. Two way communication link	This can be realised by a Single Channel per carrier (SCPC) channel on INSAT C Band transponder, either individual channel can be alloted to each link or one single SCPC channel can be worked in a random multiple access. This channel will support a data link with 32 kilobits/sec data rate or a voice link which can be adequate for transfer of data/instructions.
2. Broadcast link	This can be accomplished by an injected carrier SCPC link through INSAT broadcast transponder. This channel will support a voice broadcast and will be able to link all CMO TPs with ACWC/CWC TPs for transfer of TP data
3. Broadcast links in extreme emergency	This is contemplated to be achieved by using the broadcast channel as in 2 with full TV broadcast channel EIRP instead of the injected mode. As a result cheap receivers can be used for receiving CWMC. Thus it will be possible to use sea going vessels and groups of fishing boats with low cost receivers.

2.113 THE TC SYSTEMS ABOARD INSAT-1A :

The table 2.16 gives the finally achieved system capability of the INSAT-1A satellite. The frequency plan is shown also in fig. 2.37.

TABLE 2.16

INSAT-1A SYSTEM CAPABILITIES

Facility	Utilisability
1. Twelve 36 MHZ wide transponders in the ranges 5.935-6.425 GHz (Earth-Satellite) and 3.710-4.200 GHz (Satellite-Earth) with 32 dbW (min) EOL EIRP over primary coverage area. Provisions for 4000-5000 2 way long distance telephony circuits	a) Thick and thin route truck traffic b) Remote area communication. c) Emergency communication TV distribution
2. Two 36 MHz wide direct TV broadcast transponders in the ranges 5.855-5.935 GHz (Earth-Satellite) and 2.555-2.635 GHz(Satellite-Earth) with 42 dbW (min) EOL EIRP each. National coverage	a) Direct TV broadcasting to augmented low cost community TV sets in rural areas, b) TV programme distribution c) Radio programme distribution d) Disaster warning
3. A Very High Resolution Radiometer (VHRR) with Visible (0.55-0.75 um) Infra Red (10.5-12.5 um) channels with resolutions 2.75 kms and 11 kms respectively with full earth coverage every 30 minutes.	Round the clock, half hourly synoptic observation of weather systems including cyclones over India and adjoining lands and sea areas, sea surfaces and cloud top temperature, water bodies and snow mapping observations, etc.
4. One 200 KHz bandwidth data channel operating in the ranges 402.75 + 0.1 MHz (Earth-Satellite) and 4038.1 + 0.1 MHz (Satellite-Earth) bands in the random access mode capable of handling DCPs.	Relay of meteorological, hydrological and oceanographic data from unattended autonomous DCPs.

Legend : EOL = End of life, EIRP = Equivalent Isotropic Radiated Power

2.114 SATELLITE IMAGERY RECEIVING TERMINALS IN INDIA PROPOSED/INSTALLED UNDER THE INSAT-1 PROGRAMME :

Table 2.17 gives the Satellite Imagery receiving terminal stations that have been installed in India or are being proposed under the INSAT-1 programme.

TABLE 2.17

INSAT TELECOMMUNICATION GROUND SEGMENT DEDICATED TO CYCLONES

Centre	Location	Uplink/ Downlink	Purpose
I. Data Collection System - DCPs	Given in Appendix 2.5 paragraph 2.328 Table 2.41	402.75 MHz/ 4.038 GHz	Establishes Communication between INSAT and the DCPs for collection of weather d data and dissemination to TSOES-Delhi
VHRR abroad IN INSAT		Downlink 4.03 GHz	To communicate cloud pictures taken by AVRR via INSAT TSOES-Delhi
II. Data Receiving and Processing System			
Satellite Control/Twin Satellite operation Earth Station (TSOES)	Secunderabad (Uttar Pradesh)	Uplink 2.258 6.262 GHz/ Downlink 4.031, 4.039 GHz	Establishes communication with INSAT for receiving Meteorological data
Meteorological Data Utilisation Centre (MDUC)	New Delhi	Linked to TSOES	Receives meteorological data from TSOES-Delhi

Centre	Location	Uplink/ Downlink	Purpose
Secondary Data Utilisation Centre (SDUC)	At all ACWC/ CWCs and at WC-Pune	Linked to MDUC by TP and other TC channels	Receives processed meteorological data from MDUC
Link between MDUC RTH, New Delhi, WC-Pune and ACWC/CWCs		IMD Telecommunication channels	Exchange of weather information
III. Disaster Warning System (DWS)			
ACWC/CWCs		Uplink 5.815 5.915 GHz	Sends cyclone warnings in an emergency to authorities of of coastal states
DWS receivers	Located with authorities of coastal state. Locations still uncertain. In the first phase DWS will be tried on a coastal strip of Tamil Nadu	Downlink 2.575 2.615 GHz	Receives cyclone warnings in an emergency from the ACWC/CWCs via INSAT

A more detailed description of all the stations of the ground segment of APT systems and the INSAT is given in Table 2.44 of Appendix 2.7 (paragraph 2.33) of this chapter. The proposed INSAT network is shown as a fig.2.24. The proposed Disaster Warning System (DWS) is discussed in paragraph 2.170.

2.115 NEED FOR REDUCING AND RATIONALISING THE LINKS BETWEEN THE INSAT SYSTEM AND THE CYCLONE MONITORING STATIONS OF THE IMD :

The Committee considered the proposal and thought there was scope for reducing and rationalising the number of links. It recommended :

CRC/65 : For the purpose of collection of cyclone data and dissemination of Cyclone Warning Messages it would be sufficient to establish via INSAT-1. S and C Band capabilities two way communication links between the MDUC the ACWC/CWCs and the DCPs. The Easth Stations necessary for this purpose may be established.

IV.B(3) SHIP DATA COLLECTION/ADVISORY ISSUANCE SYSTEM

2.116 COLLECTION OF SHIP DATA AND DISSEMINATION SYSTEMS FOR CYCLONE WARNINGS TO SHIPS/COASTAL VESSELS/ FISHING BOATS VIA P&T/AIR RADIO STATIONS IN THE COASTAL STATES :

Ship data are collected at the RCCs at Bombay, Calcutta and Madras by the P&T and AIR coastal radio. They also broadcast the weather/storm advisories and cyclone warning messages (CWMs) from the ACWC/CWCs six times a day. The weather bulletins are broadcast by the P&T radio stations in Bombay, Calcutta and Madras. The coastal Bulletins are broadcast by 6 P&T coastal radio stations on the west coast and 4 on the east coast and one in the Andaman Group. Also there are about 23 AIR stations in the coastal states of India broadcasting weather/storm advisories to fishermen. Table 2.63 in the appendix 2.14 (paragraph 2.355) and table 2.68 (paragraph 2.358) gives a list of the coastal P&T radio stations and some informations above their broadcast schedules. The list of AIR stations in the coastal state is given in table 2.68. appearing in the appendix 2.15 9paragraph 2.360). Detailed information about various types of meteorological services for shipping, coastal vessel and fishermen are given in paragraphs 2.151-2.155. Table 2.18 gives the distribution of the radio stations maintained by various agencies on the Indian coast which are used to render the various types of meteorological services that are necessary (paragraph 2.152).

TABLE 2.18

DISTRIBUTION OF RADIO AND WT STATIONS FOR WARNING TO SHIPS

Bulletin/Warning Type	State where station located	Agency	Number of Station
1.Weather Bulletin	Maharashtra	P&T	1
	Tamil Nadu	do	1
	West Bengal	do	1
		Total	3
2.Fleet Forecast	Maharashtra	Defence	1
	Andhra Pradesh	do	1
		Total	2
3.Coastal Bulletin	Andaman Group	P&T	1
	Andhra Pradesh	do	1
	Goa	do	1
	Gujarat	do	1
	Karnataka	do	1
	Kerala	do	1
	Maharashtra	do	2
	Tamil Nadu	do	2
	West Bengal	do	1
		Total	11
4.Fishermen warning	Andaman Group	AIR	1
	Andhra Pradesh	do	3
	Goa	do	1
	Gujarat	do	2
	Karnataka	do	4
	Kerala	do	3
	Maharashtra	do	2
	Pondicherry	do	1
	Tamil Nadu	do	3
	Orissa	do	2
	West Bengal	do	1
		Total	23

In addition to listening to those regular broadcasts of the coastal radio stations, the coastal shipping and ships on high seas can transmit their data to those stations and interrogate them when needed. The satellite system INMARST programme the Government of India proposes to set up a coastal Earth Station close to the centre of major Indian marine shipping interests. It will provide TLP/TLG and other forms of modern communication services for ships plying in the seas round the Indian region.

2.117 RECENT STRENGTHENING OF P&T COASTAL RADIO STATIONS AT BOMBAY, CALCUTTA AND MADRAS :

Recently the P&T coastal radio stations have been strengthened. At each of the three places Bombay, Calcutta and Madras one transmitter of 2.5 KW power in the MF range has been established to provide a dedicated channel round the clock for broadcasting weather messages. A seperate Radio Telephone (RT) has been established at these coastal stations to ensure that the transmitter and the receiver is never detuned so as to be always available for reception/acknowledgement of weather messages.

IV.B(4) TELECOMMUNICATION SYSTEMS USED FOR THE CYCLONE WARNING SYSTEM (CWS)

2.118 TELECOMMUNICATION NETWORK OF THE IMD :

The IMD has set up on elaborate Cyclone Warning System (CWS) covering both coasts of India. The back bone of the system is the telecommunication channels of the Post & Telegraph Department consisting of Land Line Telegram (LLT), Teleprinter lines (TP), Telex (TLX) systems and Telephones (TLS). IMD also employs Wireless Telegraphy (WT) systems, Radio Teletype (RTT) systems and has facilities for Facsimile (FAX) broadcasts and receptions. IMD does not have its own land line microwave links. It has facilities for automatic picture receptions from Satellites. With the Establishment of the INSAT Earth Stations IMD has acquired added telecommunication (TC) facilities which have been reviewed in paragraph 2.113. The facilities of the AIR radio stations and the coastal P&T radio stations are also extensively used and to a lesser extent the broadcasting facilities of the WT system of the Indian Navy and the coastal Railway Stations for dissemination of weather bulletins. At present IMD has meteorological centres at 78 cities of India. The details of the total number of Telecommunication channels (TCC) available to the IMD are given in table 2.19.

TABLE 2.19

LIST OF METEOROLOGICAL TELECOMMUNICATION CHANNELS OF THE IMD AS ON 1.1.1983

Type	Number
A. INTERNATIONAL CIRCUITS	
1. Radio/Satellite data circuits (Bangkok, Cario, Colombo, Dhaka, Jeddah, Karachi, Melbourne, Moscow, Teheran, Tokyo)	10
2. Land Line TP (Kathmandu)	1
3. Satellite point to point Facsimile (FAX) circuit (Moscow)	1
B. NATIONAL CIRCUITS	
1. Teleprinter Links (TP)	86
2. Telex Systems (TLX)	47
3. Stations linked by Wireless Telegraphy (WT)	36
4. Radio Teletype (RTT) Reception Centres	21
5. FAX Reception Centres	21
6. Automatic Picture Transmission (APT) Reception Facilities	7

The telecommunication net works of the IMD are shown in figures 2.25, 2.26, 2.27, 2.28, 2.29, 2.30, 2.32. In view of the importance of the communication system in the Meteorological Services, a Directorate of Telecommunication was set up at Delhi in 1969 for the functional control of Meteorological Telecommunication in the Department. The Committee recommended :

CRC/66 : Since the P&T TCCs form a vital part in the successful operation of the Cyclone Data Collection

System (CDCS) and the Cyclone Warning System (CWS), the P&T Department should establish a special cell for improvement/maintenance/supervision of these TCCs so that these can function at the level of maximum efficiency.

2.119 NEED FOR TRANSMISSION OF FAX WEATHER CHART IN CODED DIGITAL FORM :

At present FAX weather charts are exchanged on n national/international circuits in an analogue mode which suffers from a number of draw backs : mutilation in transit/ incomatibility with digital computer/slow speeds. It is proposed to make a beginning in transmission in coded digital form.

2.120 NEED FOR TC SYSTEMS IMMUNE TO CYCLONE :

Unfortunately experience has shown that the normal P&T channels : LLTs, TP, TLX and Telephone (TTF) are unreliable and almost invariably fail when they are needed most i.e. during cyclone regimes. It was mentioned in a discussion at a meeting of the Committee that the Cyclone Warning System (CWS) was tested once under normal conditions and it was found that it needed much improvement. It is true that with the establishment of the INSAT facility a considerable improvement in the CWS is expected. But it must be realised that Satellites are quite susceptible to component failures which can seldom be ractified by ground commands. Indeed this is what happened with INSAT-1A. So the wise strategy would be to base the CWS mainly on land based TCCs like WT, RTT, FAX, UHF/VHF, Microwave channels also which are comparatively immune to cyclones and can be easily maintained. The Committee therefore recommended :

CRC/67 : The Cyclone Warning System (CWS) set up by the IMD should be progressively based on telecommunication systems (TCCs) like Wireless Telegraphy (WT), Radio Telephony (RT) and Radio Teletype (RTT). Facsimile (FAX) transmission system, Very High Frequency/Ultra High Frequency (VHF/UHF) communication systems and Microwave systems, all of which are comparatively immune to cyclones. The INSAT system should also be rapidly put into operation to supplement the other TCCs used in the CWS.

CRC/68 : It would benefit the Cyclone Data Collection System (CDCS) and the Cyclone Warning System (CWS) of the IMD if the P&T Department establishes reliable cyclone proof TC linkages between the P&T communication centre in

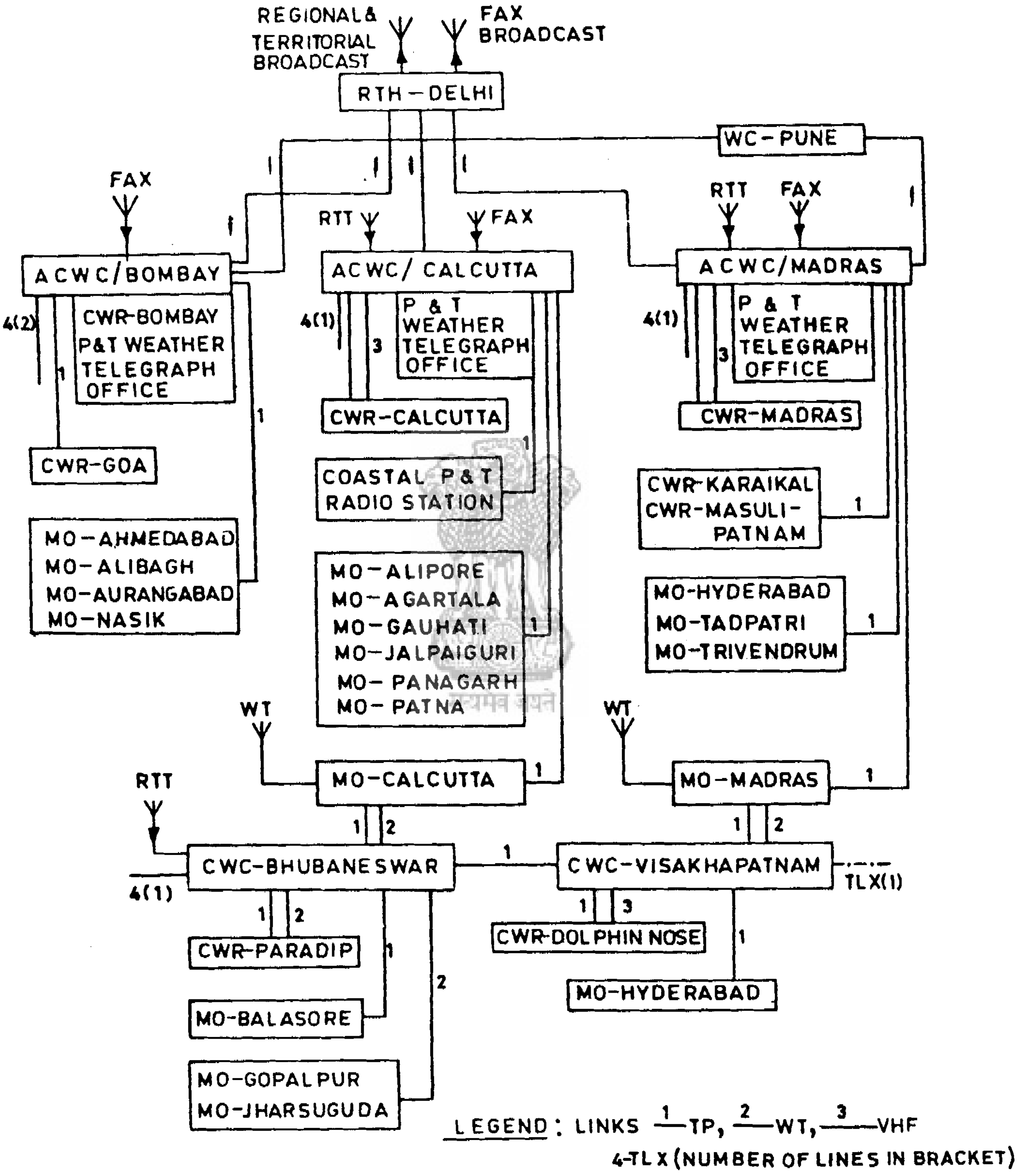


Fig.2.25 Telecommunication channels (TCCs) available at the ACWC/CWCs. Reference 28

each coastal state and the various data collection/forecasting centres of the IMD of which the most important in the matter of cyclones are the ACWC/CWCs.

2.121 NEED FOR A UHF/MICROWAVE TCC FOR THE IMD :

The experience of the Indian Railways with their microwave telecommunication systems has been very satisfactory. The Committee recommended :

CRC/69 : The P&T Department should provide to the IMD/UHF and Microwave telecommunication channels on lease for this project High priority should be given to create a net work for the Cyclone Warning System (CWS) in the CPARs of India. For this purpose considerations of economic viability should not stand in the way.

2.122 ALTERNATIVE TCCs AVAILABLE TO THE IMD DURING CYCLONES :

In times of emergencies like those which arise during cyclone regimes when normal P&T telecommunication channels fail, alternative TCs are available, in principle, to the IMD. The most important of these are

1. Police WT System
2. Railways Microwave Channels
3. Aeronautical Fixed Telecommunication Net Work (AFTN) of the Civil Aviation Department.

While the Police WT System have been used during extreme emergencies, the other two channels, though available, may not have been used for the CWS, or if used, it is not known how efficient these systems proved to be. Railways are building an extensive microwave net work on the east coast. It is understood that it may be available in case of failures of normal channels for specific tasks like transmitting observations from coastal stations or providing a link upto the District Headquarters. The Committee recommended :

CRC/70 : The Railway microwave net work set up on the east coast and the Aeronautical Fixed Telecommunication Network (AFTN) system of the Civil Aviation and Tourism Department should be used in periods of extreme cyclone emergencies where all the normal TC channels have failed.

2.123 P&T TC NETWORK IN THE COASTAL STATES OF INDIA*:

There exists an elaborate TC network of the P&T in the coastal states of India which is being improved and modernised. The modernisation consists in addition of Coaxial, UHF and Microwave segments to the network. Figures 2.48, 2.49 and 2.50 give maps of these networks established/ proposed. Tables 2.55, 2.56 and 2.57 in paragraph 2.349-2.351 in appendix 2.12 give a list of the established/ proposed links under this category. In times of cyclone emergency it should be possible to use these networks for cyclone warning dissemination. No representative from the Railways attended the meetings of the CRC, so it was not possible to obtain informations of the Railway Microwave Network on the east coast.

2.124 POLICE WT STATIONS IN THE COASTAL STATES :

The Police Departments of each state has eleborate TC systems which links all police stations in District Headquarters. An important component of this system in the system of the WT/RT channels, some of which are described for the state of Orissa, Tamil Nadu and West Bengal in table 2.59 appendix 2.12 (paragraph 2.352). In West Bengal the system is mainly based on the RT channels. In Tamil Nadu the VHF channel is also being employed. Due to certain limitations in the VHF sets in Tamil Nadu - single channel/ limited range/limited clarity of transmission of microwave links have been sanctioned in the route Madras-Javadi Hills-Yercaud-Kodaikanal-Madurai for the Police Department. In the Anti Disaster Plan the Government of Tamil Nadu has proposed for the Police Department

1. UHF Static Transreceivers with in built 5-channel Equipment - range 100 km, capable of being linked to proposed microwave network of the state,

2. UHF Mobile Transreceivers mountable on mobile vehicles. These are single channel with range 100 km,

3. UHF Manpack Transreceivers carried by manpower. These also have single channel and range 100 km.

In every state similar efforts are being made to improve the communication system of its Police Department.

IV.B(5) TCCs FOR THE ACWC/CWCs

2.125 DATA COLLECTION BY THE ACWC/CWCs :

Data collection is a basic function of the ACWC/CWCs, for without these data Pune-WC can not make any assessment of the coastal weather. Speed in collection of data is also very important in order that a proper assessment of weather disturbances can be made in time. The observation stations are the coastal surface and upper air observatories, the DCPs, the Cyclone Warning Radars, the Tide Gauge Stations, APT and satellite imageries receiving stations and aircraft probes when this facility is created.

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* Information given by Shri R. Lalwani, Director(MR) P&T Department.

2.126 THE TELECOMMUNICATION FACILITIES AVAILABLE AT THE ACWC/CWCs :

The TCC facilities available at the ACWC/CWCs are given in Table 2.20.

TABLE 2.20

TCCs AVAILABLE AT THE ACWC/CWCs

Type	Calcutta	Bhubaneswar	Visakhapatnam	Madras	Bombay
1. P&T	a) One direct to Calcutta-CWR	To 1.Calcutta-ACWC via Calcutta-MO	To 1.Bhubaneswar-CWC 2.Hyderabad-MO	a) Direct to 1.Karaikal-CWR 2.Madras-CWR	Direct to 7 centres 1.Ahmedabad-MO 2.Alibagh-MO
	b) To 9 Centres 1.Agartala-MO 2.Alipore-MO 3.Bhubaneswar-CWC via Calcutta-MO 4.Calcutta-MO 5.RTH-Delhi 6.Gauhati-MO 7.Jalpaiguri-MO 8.Panagarh-MO 9.Patna-MO	2.Balasore-MO	3.Madras-ACWC via Madras-MO 4.Visakhapatnam-CWR	3.Masulipatnam-CWR b) to 7 Centres 1.RTH-Delhi 2.Hyderabad-MO 3.Madras-MO 4.Pune-WC 5.Tadpatri-MO 6.Trivandrum-MO 7.Visakhapatnam-CWC via Madras-MO	3.Aurangabsf-MO 4.RTH-Delhi 5.Goa Panaji-CWR 6.Nasik-MO 7.Pune-WC

2.Telex	One line existent + One line proposed	Two lines	One line	One line	Two lines
3.P&T Departmental Telegraph Office	Located inside the ACWC	-	-	Located inside the ACWC	Located inside the ACWC
4.Coastal P&T Radio	One tie line for reception of ship observation	-	-	-	-
II.Wireless Telegraphy (WT)	via Calcutta -MO	Link with 1.Calcutta -MO 2.Gopalpur -MO 3.Jharsuguda -MO 4.Paradeep -CRS	Existent	via Madras -MO	Existent
III.Radio Teletype (RTT) & Facsimile (FAX) Broadcast/ Reception	Both facilities existent	RTT facility existent	-	Both facility existent	FAX reception facility existent
IV.VHF Link	with Calcutta-CWR	-	with Visakhapatnam-CWR	with Madras-CWR	CWR located within ACWC

The Committee recommended :

CRC/71 : The weather telegraph offices (WTO) of the P&T should also be located within the premises of the CWCs as has been done for the ACWCs.

CRC/72 : When the proposed CWC at Gujarat is established it should be provided with reliable TC systems as the other ACWC/CWCs.

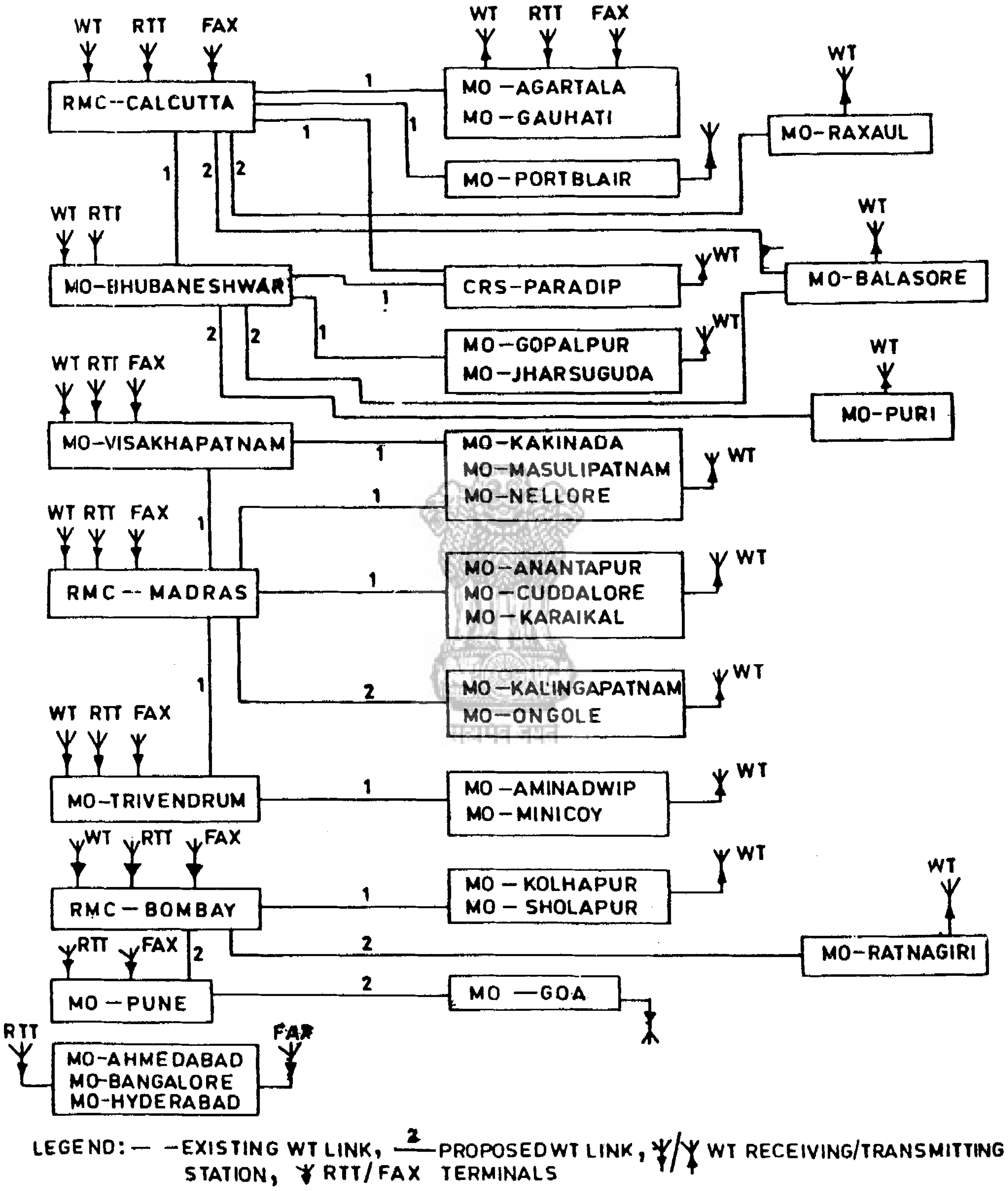

Fig.2.26 IMD WT network and RTT/FAX terminals in Coastal India. Reference 28, 29

2.127 NEED FOR A COASTAL WT NETWORK LINKING THE ACWC/CWCs TO THE CMO/IMOs :

The ACWC/CWCs should be able to receive the data directly from the coastal surface and upper air observatories by a weather proof telecommunication channel. The TCC should be immune to weather because the observations have to be taken during cyclone regimes. At present the land based P&T channels are used for this purpose and these are not reliable. WT systems are weather proof and even small powered transmitters have ranges 50-100 miles. This system should constitute the basic system for transmitting weather data from these coastal observatories to the ACWC/CWCs. Because of the length of Andhra Pradesh coast the limited range of the WT transmitters may create problems. If however a CWC is set up in South Andhra Pradesh as suggested by the Committee (CRC/63) this problem may be resolved. Thus a coastal WT/TP/TLX net work is needed of which a beginning has been made already by the P&T Department who have put a total of 36 meteorological stations on their departmental WT net work of which about 32 are in the coastal states. Table 2.21 gives a list of the meteorological units in the coastal states where WT transmitters are installed.

TABLE 2.21

METEOROLOGICAL CENTRES IN COASTAL STATES
WITH WT TRANSMITTING FACILITY

State	Centre	Remarks
1. Andaman Group	Port Blair	During cyclone season
	1	
2. Andhra Pradesh	Anantapur	
	Kakinada-MO	
	Masulipatnam-CWR	Proposed
	Nellore-MO	
	Ongole-MO	
	Visakhapatnam (Air Port)	
	Visakhapatnam	
	7	
3. Goa	Goa-CWR	
4. Kerala	Trivandrum Airport	
	Trivandrum - MO	During Cyclone season

State	Centre	Remark
5. Lakshadwip Group	Amindivi-MO	
	Minicoy-MO	During Cyclone season
	2	
6. Maharashtra	Amroti-MO	
	Bombay-MO	During cyclone season
	Kohlapur-MO	
	Ratnagiri-MO	Proposed
	Sholapur-MO	
	6	
7. Orissa	Bhubaneswar-MO	During cyclone season
	Balasore-MO	Proposed
	Gopalpur-MO	
	Paradeep-CWR	During cyclone season
	Puri-MO	Proposed
	5	
8. Tamil Nadu	Cuddalore	During cyclone season
	Karaikal-CWR	
	Madras-Airport	
	Madras-MO	
	4	
9. West Bengal	Calcutta-Airport	
	Calcutta-MO	During cyclone season
	Sagar Islands	
	Sand head	
	4	
Total	32	

2.128 NEED FOR THE ACWC/CWCs AND THE CMO/IMOs TO BE INDEPENDENT OF THE POLICE WTs FACILITIES :

Since the Police communication system of each state cover its very closely bringing the Police stations in contact with the District Headquarters, it was suggested that the Police WT channel should provide a most valuable means of weather data collection and dissemination of CWMs. Also since the Police maintain mobile WT units, CDMC had suggested that some of the wind observations taken at the coastal observatories could be transmitted to the ACWC/CWCs by these units. But since this request would interfere with the normal duties of the Police for which these channels have been set up, the Police authorities have generally expressed their inability to help. Thus it is advisable not to depend on this means of communication for the CWS as an alternative channel in a cyclone emergency though the Police W/T system has often been available.

2.129 NEED TO EQUIP THE CMO/IMOs WITH WT/RT FACILITIES :

The Committee recommended :

CRC/75 : All the CMO/IMOs should in course of time be equipped with their own WT/RT facilities for communication with the corresponding ACWC/CWC for transmitting to it the meteorological data collected by them. The ACWC/CWCs also should be similarly equipped to communicate with the CMO/IMOs under their control.

2.130 PERMISSION GRANTED SO FAR TO OPERATE RT FROM THE CMO/IMOs DURING CYCLONE SEASON :

An important recent development is permission given by the Ministry of Communication to operate Radio Telephone from coastal/island meteorological stations during the cyclone season. The facility has been established at (1) Minicoy, (2) Trivandrum, (3) Madras-MO, (4) Cuddalore-MO, (5) Bhubaneswar-MC, (6) Paradeep-CWR, (7) Calcutta-MO, (8) Port Blair. Four more stations have not been permitted to have the same facility. Thus direct transmission will be possible and persons trained in morse will not be needed. This is an important addition to the data collection system.

2.131 NEED FOR CYCLONE PROOF TC LINKAGE BETWEEN THE ACWC/CWCs AND THEIR CWRs :

When the cyclone crosses into the Radar Horizon it has to be monitored by the Cyclone Radars and it is therefore important that ACWC/CWCs have cyclone proof linkage with the corresponding CWR. It was reported in the meetings of the CRC and it will be also seen from Table 2.20 that except for the CWR at Paradeep and the newly set up CWR at Masulipatnam, VHF linkage exists between the ACWC/CWC and its corresponding CWR except at Bombay where no such linkage is necessary for the ACWC/and the CWR are located at the same place. Another CWR is proposed at Karaikal. The Committee therefore recommended :

CRC/74 : The CWRs at Karaikal, Masulipatnam and Paradeep should be connected to the corresponding ACWC/CWC by HF linkage.

2.132 NEED TO DETAIL P&T STAFF WITHIN THE ACWC/CWCs DURING THE CYCLONE REGIMES :

To take care of the existing land based telecommunication channels, the Committee reiterated the recommendations made in the Cyclone Project by the IMD (IMD-CP/11(i)).

CRC/75 : During a cyclone regime, the P&T Department should position its maintenance staff within the ACWC/CWCs and other concerned meteorological offices for prompt and speedy rectification of faults in the telecommunication channels or their restoration in case of breakdown of communications.

2.133 NEED FOR STANDBY DIESEL GENERATORS TO SERVE THE VARIOUS CYCLONE MONITORING CENTRES IN CASE OF POWER FAILURE DUE TO CYCLONE :

The power supply to the P&T and the AIR Coastal Radio Stations and the Coastal CMO are liable to snap when a cyclone is in full fury. Also it is an unfortunate fact that in some cities like those in West Bengal, the electricity supply is very erratic. The Committee therefore recommended It was noted that 10 KW transmitters can run round the clock on standby Diesel generators. It is difficult to run transmitters of higher power in this way. The Committee recommended :

CRC/76 : The P&T and the AIR Coastal Radio Stations with transmitters upto 10 KW power should have standby diesel generators sets. The CMO/IMOs using IMD WT/RT channels may also be provided with similar standby generators.

IV.B(6) TCCs FOR TIDE GAUGE STATIONS

2.134 NEED FOR AUTOMATISATION OF THE TGSs AND FACILITIES FOR AUTOTELECASTING FROM THEM :

It has been mentioned (paragraph 2.78) that the TGSs are at present managed by the Survey of India. The Rain Gauges are sometimes of the self recording type and are the RGSs are sometimes provided with WT facilities (paragraph 2.77). The recommendation for a TCC immune to cyclone for TGSs has been given already by the Committee (CRC/46). The Committee recommended :

CRC/77 : If the experience of the DCPs telecasting their informations via the INSAT System to the ACWC/CWCs and the RCC/SCCs is encouraging, then the IMD may consider setting up its own network of automatised and self telecasting Tide Gauge Stations at selected points in cyclone prone areas which are vulnerable to storm surges. A beginning may be made with a few experimental stations in Andhra Pradesh and West Bengal.

IV.C CYCLONE SERVICES

IV.C(1) THE CYCLONE WARNING AGENCIES/WARNEES

2.135 THE CYCLONE WARNING AGENCIES/WARNEES :

A list is given below :

1. The ACWC/CWCs : The functions/organisations of these centres have been already described in paragraph 2.98. Apart from keeping a watch on the weather generally, the most important functions of the ACWC/CWCs are to forecast cyclones and warm the various categories of cyclone warnees. The warnings relate to observed parameters of a cyclone, particulars of its movements landfall possibilities/destinations and the state of the sea.

2. Flood Forecasting Centres (FFCs) : These have been discussed in paragraph 2.103. Various organisations - CWCM/State Governments/Railways/Forest Departments/IMD have set up HMOs (Hydrometeorological observatories) to serve their special needs and flood forecasting is an important task which is required of them. Some coastal states like Tamilnadu which are prone to cyclones did not have FFCs of the CWCM located in the state at least upto recently. But it is not very clear whether the FFCs are expected to issue warnings about storm surges from the sea brought by the cyclone.

The Cyclone Warning System has become very elaborate and complex. The Committee felt that there was need for a central organisation to coordinate the activities of the system. It recommended therefore :

CRC/78 : An organisation should be created and located at the IMD Head Quarters at Delhi, which is dedicated to coordinate/supervise the totality of the Cyclone Working Programme. A Cyclone Warning Directorate (CWDR) at Delhi may serve this purpose. One of the tasks of this body should be to guide the work of the Cyclone Assessment Cell (CAC) proposed by this Committee in CRC/61.

2.136 VARIOUS AGENCIES USED FOR CYCLONE WARNING DISSEMINATION (CWD)* :

With the revolution of audio media caused by the development of transistors, medium wave receivers have become so cheap that they have reached the village communities. It was therefore a very wise decision to use the All India Radio to broadcast cyclone warnings. The other agency used for this purpose is the P&T Department of the Government of India. The CWD is also based on Land Line Telegrams (LLTs), Teleprinters (TPs), Telex, Telephones and coastal P&T radio stations. The INSAT is proposed to be used in a Disaster Warning System which is being set up and can be used for cyclone warning.

2.137 AIR STATIONS IN THE COASTAL STATES USED FOR CWD** :

For the warnees among the general public and also for many categories of other warnees, All India Radio (AIR) is the main medium through which the CWM messages are received. Table 2.22 gives the distribution of AIR stations in coastal states. Table 2.68, 2.69, 2.70 of appendix 2.15 paragraph 2.360-2.362) give respectively the list of the AIR stations in the MF and HF ranges and the Doordarshan centres. Fig. 2.52 of appendix 2.15 (paragraph 2.260 indicates their locations in the coastal states.

TABLE 2.22

DISTRIBUTION OF AIR MW RADIO STATIONS IN THE COASTAL STATES USED FOR CYCLONE WARNING

State	Number of locations	(1-5KW)	(5-50KW)	Number of Services (Over 50 KW)	Total
A. East Coast					
1. Andaman Group	1	1	1		2
2. Andhra Pradesh	4	2	4	1	7

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* Working paper 20 placed before the Committee by IMD

** IMD Cyclone Manual : Chapter 9
Weather Service to shipping, fishing vessels and maritime interests (1974)
Home Programme Wavelength Schedule (2nd May-4th September 1982)
Director General AIR (Government of Ihdia).

State	Number of loca- tions	(1-5KW)	(5-50 KW)	Number of Services (over 50 KW)	Total)
3. Orissa	3	1	2	1	4
4. Pondicherry	1	1	-	-	1
5. Tamilnadu	5	3	4	-	7
6. West Bengal	3	1	3	3	7
	17	9	14	5	28
B. West Coast					
1. Goa	1	1	1	-	2
2. Gujarat	4	3	3	-	6
3. Karnataka	7	4	5	-	9
4. Kerala	4	2	3	1	6
5. Maharashtra	6	2	7	1	10
	22	12	19	2	33

2.138 P&T RADIO STATIONS IN THE COASTAL STATES USED FOR CWD* :

A number of P&T radio stations in the coastal states are used for providing whether warnings to merchant vessels. The most important of these are the stations at Bombay (call sign VWB), Calcutta (call sign VWC) and Madras (call sign VWM). Table 2.23 gives the distribution of these radio stations.

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* IMD Cyclone Manual : Chapter 9.

Weather Services to shipping, fishing vessels and marine interests : IMD (1974).

TABLE 2.23

DISTRIBUTION OF P&T RADIO STATIONS IN COASTAL STATES USED FOR CYCLONE WARNING

	Eastern Coast		Western Coast	
	State	Number of (Stations)/ Number of (Frequency)	State	Number of (Stations) /Number of (Frequency)
P&T radio stations	1.Andaman Group	1/1	1.Goa	1/1
	2.Andhra Pradesh	1/1	2.Gujarat	1/1
	3.Tamilnadu	2/3	3.Karnataka	1/1
	4.West Bengal	2/5	4.Kerala	1/1
			5.Maharashtra	2/5
		5/10		6/9

Table 2.63 and 2.66 in the appendix 2.14 (paragraph 2.351 and 2.358) give the actual locations of these stations.

2.139 COASTAL WT STATIONS OF THE INDIAN NAVY FOR PROVIDING WEATHER INFORMATIONS TO SHIPS OF THE INDIAN NAVY* :

Weather broadcasts for Indian Navy ships are made through naval telecommunication channel. The naval wireless station at Bombay (call - sign VTG) broadcasts Extra, Storm and Special bulletins and all coastal bulletins. Visakhapatnam naval wireless station (VTP) broadcasts twice a day a sea bulletin issued by ACWC-Calcutta for the Bay of Bengal and portions of the Indian Ocean. ACWC-Bombay issues sea bulletins for the Persian Gulf, the Arabian Sea and the Indian ocean. These and the sea bulletins issued by SHAC-Poona for a portion of the Indian Ocean are broadcast by Bombay-VTG. The timings and frequencies of broadcasts from naval WT stations are given in Table 2.65 - appendix 2.14(paragraph 2.357).

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* IMD Cyclone Manual : Chapter 9

Weather Service to shipping, fishing vessels and meritime interests - IMD (1974)

2.140 CYCLONE WARNEES* :

In paragraph 2.98 the responsibility of the ACWC/CWC to issue CWMs and other associated advisories to different categories of Warnees have been described. Table 2.24 gives a brief list of such warnees :

TABLE 2.24

LIST OF WARNEES

Land Line Telegram Code	Warnees
I. Code 000 (Weather immediate) All copies of these telegrams sent to DG and DDGM Weather Forecasting (WF)	1. Chief Secretary of a Maritime State 2. Government Officials of that State District Collectors 3. Central Government Officials (a) Port Officials (b) Designated Railway Officials (c) Designated Defence Officals (d) AIR
II. Code XXW	1. State Government Officials (a) District Collectors (b) Irrigation Officials (c) Road and Transport Officials (d) PWD Officials 2. Central Government Organisations (a) Port Officials (b) Designated Railway Officials (c) Designated Defence Officials (d) AIR for transmitting Cyclone Bulletins (e) Warnings to ships and coastal vessels through P&T and AIR Coastal Radio Stations

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* IMD Working Paper 20 put before the Committee.

Land Line Telegram Code	Warnees
	(f) Fisheries (i) AIR for fisheries warnings (ii) Designated Fisheries Officials
	(g) Designated P&T Officials
	(h) Designated Revenue Officials
	(i) Coastal Meteorological Offices
	(j) Airport Offices
	3. Album Page Warnees
III. Code XXT	Officials of the P&T Department as prescribed in the Album page
IV. Code BGXQ	For press

Among the album page warnees are listed officials of the Revenue, PWD, Irrigation, Highways, P&T and Railways Department etc. This list is reviewed periodically and is extended on request from new customers for cyclone warning. An important category of warnees consists of the merchant/coastal vessels and fishing boats/fishermen, ships of the Indian Navy and the airlines.

IV.C(2) CYCLONE WARNING MESSAGES/CYCLONE ADVISORIES/ CYCLONE BULLETINS (CWM/CA/CBs)

2.141 TWO STAGE CYCLONE WARNING SYSTEM OF THE IMD* :

At present the Cyclone Warnings is issued by the ACWC/CWC in two stages : First stage - Cyclone Alert, Second Stage - Cyclone Warning. Cyclone Alert is given 48 hrs before the expected start of bad weather and Cyclone Warning 24 hrs before the onset of adverse weather, which is then to be continued twice a day at 0830 hr and 1730 hr IST till the cyclone is dissipated. In addition the warnees are advised to listen to AIR broadcasts on weather after the second state warning has been issued.

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* IMD Working paper 20 put before the Committee.

2.142 CLASSIFICATION OF STORMS* :

The storms are generally classified by the maximum wind speeds in their field as shown in table 2.25.

TABLE 2.25

PRESENT CLASSIFICATION OF CYCLONES BY MAXIMUM WIND SPEEDS

Storm Type	Wind Speed	
	km/hr	knot
1. Low Pressure Area	Less than 31.5	17
2. Depression	31.5-50	17-27
3. Deep Depression	51.9-61.2	28-33
4. Cyclone	63-87.1	34-47
5. Severe Cyclone	88.9-116.7	48-63
6. Severe Cyclone with a core of hurricane	Exceeding 118.6	64

For the purpose of CWMs the Committee recommended** only three categories

CRC/79 : For the CWMs, it may be more convenient for the public to grasp the magnitude of cyclones if they are classified under three catagories according to wind speeds in the cyclone fields : (1) Depression (32-50 kmph), (2) Toofan (51-89 kmph) and (3) Severe Toofan (89 kmph and above). The use of the common Indian word Toofan in place of the word cyclone is expected to be more effective and meaningful to the general categories of warnees.

2.143 SERIAL NUMBERING OF CYCLONES :

For the purpose of ready identification/reference in the case of a particular cyclone it is necessary to have a system of serially numbering them. The Committee endorsed the recommendation of the CDMC (CDMC/16) in this respect.

CRC/80 : All cyclones should be serially numbered : Cyclone : Year : X, Month : Y, Serial Number : Z. Later when the landfall point is known, the geographical characterisation of the landfall point may be added after the serial number : Landfall point : A, State : B.

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* IMD Cyclone Manual : Chapter 5

** The IMD did not accept the classification which did not conform to the international practice.

2.144 NEED FOR MAKING THE CWM/CAs INTELLIGIBLE TO LAY MEN :

The Committee recognised the need for formulating the CWMs and Cyclone Advisories (CAs) for the public in layman's language of local speeches in a way which is easily intelligible to the public. To cite an example pressure falls carry no impression in the public mind. It is necessary to evolve a glossary of meteorological terms in the local languages of the coastal states for use in the CWMs and the CAs. Some meteorological terms translated in coastal languages already in use are listed in table 2.81 and 2.82 in appendix 2.22 (paragraph 2.382). The Committee recommended :

CRC/81 : The CWMs and the Cyclone Advisories (CAs) should be drafted in layman's term in the various local languages of the coastal states. A glossary of meteorological terms in these languages should be evolved for this purpose.

2.145 DIFFERENT TYPES OF CWM/CAs TO BE ISSUED TO DIFFERENT GROUPS OF PEOPLE :

The CWMs and the CAs issued to the urban and the rural areas must necessarily be in varying degrees of sophisticated languages, and also the objectives of the warning are different for different groups of warnees. The rural coastal areas and various other specific areas would also need different kind of warnings for the various groups living there - agriculture based population, fishermen etc.

CRC/82 : The CWMs and the CAs for the rural and the urban areas should be suitably reformated to suit the special needs of the local community and the special features of the terrain.

2.146 COMPONENT PARTS OF CYCLONE BULLETINS (CBs) :

It is expected that the general public and special warnees will be warned of the imminent cyclone by the Cyclone Bulletins (CBs) which will start being issued and broadcast after the cyclone has crossed the CRH. The CBs should be in two distinct parts. The first part should be the CWMs giving all the details of the cyclone - location, direction/speed of motion, wind speeds /pressure fall and rain falls and expected landfall point. The authority of issuance of the CWMs should be the appropriate ACWC/CWCs. The second part of the CB should be the CAs giving instructions to local people about precautions to be taken, evacuation and rescue, relief and rehabilitation (ERRR) advisories/measures contemplated. The final authority of issuance of the CAs should be the Chief Secretary/District Collector of the affected coastal state. The CBs should be broadcast over AIR stations during the cyclone regime and after, as long as deemed necessary by the state authorities. The Committee recommended :

CRC/83 : The various types of informations/advisories related to cyclones should be broadcast for the public in a Cyclone affected area in two categories

1. The Cyclone Warning Messages (CWMs) for special groups of warnees containing various informations/forecasts about an impending cyclone and accompanying storm surge. This part should be issued by the concerned ACWC/CWC and broadcast by the AIR.
2. The Cyclone Advisories (CAs) which should contain informations/instructions/orders about measures of precautions/protection/evacuation/rescue/sheltering and camping/relief/rehabilitation. This part should be issued by the concerned District Collectors at his Cyclone Control Room and conveyed to the different groups of affected population/action teams of the concerned State Government through various communication channels of the latter.

Collectively the two parts should be referred to as the Cyclone Bulletins (CBs)

2.147 STORM SURGE WARNING MESSAGES :

Very few ACWC/CWCs issue clear forecasts about storm surges : Such predictions may be very complicated tasks and depend on the state of standing water in various areas of the coastal regions and the water level of the hydrodams feeding water to these areas. The Committee has recommended a close colaboration between the ACWC/CWCs and the Flood Forecasting Centres (Recommendation CRC/8). The Committee further recommended :

CRC/84 : Forecasts of storm surges should be an integral part of the CWMs and CAs and these should be made areawise in the cyclone affected regions. Forecasts should specify clearly which areas are likely to be inundated under storm surges and also the times when such surges are to be expected.

2.148 FLOOD WARNING MESSAGES :

The following describes the contents of the flood warning messages issued in Andhra Pradesh. The systems

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* Cyclone Contingency plan : Revenue Department, Government of Andhra Pradesh, Hyderabad (1981).

in other coastal states are likely to be the same with minor variation. The Chief Engineer, Major Irrigation and General carries out the detailed studies to predetermine areas which are likely to be affected by the various rivers at various stages above the warning stage. In case of areas which are chronically affected/important towns/ thickly populated villages Flood Zone Maps are prepared and are available with areas marked out as likely to be submerged at different stages of flooding of the rivers/tanks/water reservoirs. All the concerned officers are expected to know of these risk areas and in times of emergencies they are expected to concentrate their attention to these areas in preparing Flood Warning Messages which are to be generally issued by the Chief Engineer, Major Irrigation and General of the affected state. It has been recommended that whenever possible the areas likely to be severely affected should be demarcated on the fields by erection of boundary pillars. When the actual flood situation develops special flood warnings are broadcast indicating the towns/villages likely to be inundated/the approximate time of flooding/the approximate depth of inundation. Advisories regarding evacuation/rescue relief (ERR) are also broadcast. During cyclone emergencies wide spread flooding may be caused due to heavy rainfall. The Chief Engineer - Major Irrigation and General responsible for flood warnings should therefore issue flood warnings/ advisories as and when necessary during cyclone emergencies. Since the constant of storm surge warnings/advisories are similar to flood warnings/advisories, the Committee recommended

CRC/85 : The storm surge warnings/advisories broadcast during cyclone emergencies should be modelled on flood warnings/advisories

2.149 FLOOD WARNINGS/FLOOD WARNING AUTHORITY* :

The flood warning system in Andhra Pradesh is described in what follows. The systems in the other state are similar. Flood warning stages on all the rivers in the concerned State is fixed by the Chief Engineer - Major Irrigation. The warning stages are to be periodically reviewed at intervals of five years depending on the state of rivers. The revised stages are published including the names of the rivers, the tide gauge readings stationed on it, previous highest records of levels/discharges/years of occurances, its distance from important towns/villages, and downstreams which are likely to be affected etc. The revised stage publication would also indicate the levels at which Yellow/Amber/Red signals are to be hoisted. The significance of the colours

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* Cyclone contingency plan of action : Revenue Department, Government of Andhra Pradesh, Hyderabad (1981).

(1) Yellow signal : indicates advance approach of floods in the river in the reach concerned. The signal is in the nature of an alert signal for the authorities regarding probability of incoming flows.

(2) Amber Signal : indicates a signal of greater alertness

(3) Red Signal : this is meant for flood control and district officials calling their attention to the approach of high flood of such an order as may cause damage to flood protection works/ inundation of more than what is indicated in flood plan. The district authorities must then take actions for dissemination of warnings of imminent flood to the public and organise evacuations of persons affected.

2.150 SUGGESTION FOR A FORMAT FOR THE CWM PART OF THE CYCLONE BULLETIN :

The Committee suggested the following format for CAs suggested in paragraph

CRC/86 : The CWM part of the CB may be put in the following format :

FORMAT 1

FORMAT FOR THE CWM PART OF THE CYCLONE BULLETIN

1. Authority of issuance of the CWM
2. Serial Number of the Cyclone
3. Serial Number of the CWM
4. Date/time of issuance of the CWM
5. Description of the Cyclone
    - (a) Classification of the Cyclone
    - (b) Last location
    - (c) Direction of movement
    - (d) Maximum Wind Speed
    - (e) Expected landfall
        - (i) Area
        - (ii) Date/time

Legend

Coastal water 75 km from coast marked

Under VWC & VWM area B, Strait of Manar upto 77.5^{o}E and portion of D east of 80^{o}E

Under VWB area E and portion of west of 80^{o}E

Overlapping areas

A : Burma and India,
C : Bangladesh, Burma and India
D : India and Srilanka
F : India and Pakistan

P&T Radio Stations

✦ : Stations VWB, VWC, VWM for weather bulletins for ships

✕ : For coastal bulletins, for numbers against stations refer to Table 2.66

•|| : Naval wireless station

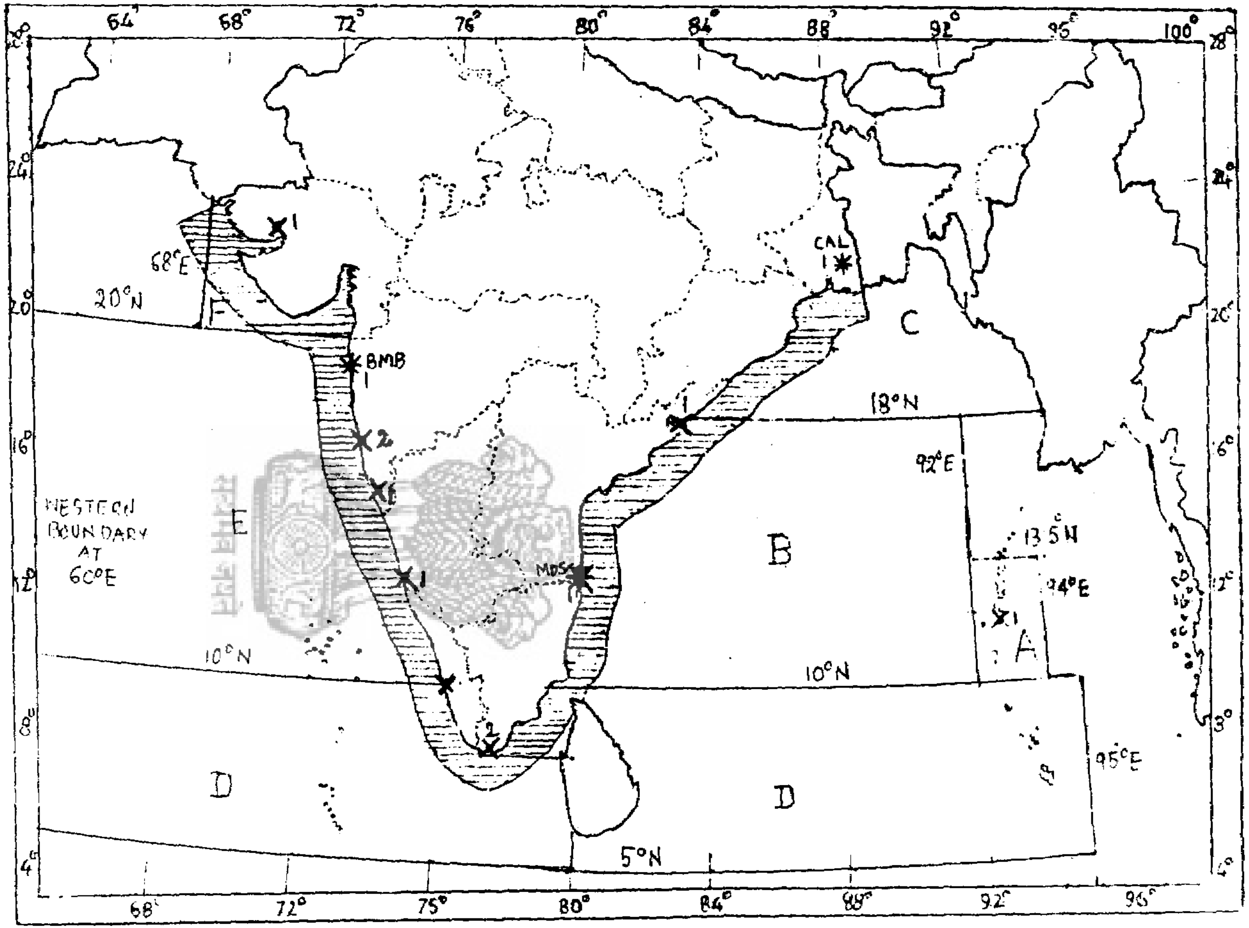

Fig.2.27 : Weather service and weather warning coastal radio stations of the P&T department and the Indian Navy for maritime/fishing interests. Reference 77

6. General Warnings to the public about wind speed (km/hr), Rainfall (mm), Storm surge (m) and state of Sea Surface for

   (a) Area of great danger (AGD)

   (b) Area of danger (AD)

   (c) Area of alert (AA)

2.151 VISUAL WARNINGS AT SEAPORTS*

At the port the visual warnings listed in table 2.62 appendix 2.13 (paragraph 2.354) are demonstrated for warning to ships in the port. There are essentially three systems of cyclone warnings : (1) The General System consisting of eleven signals, (2) The Brief System which uses five of the signals of the General System and (3) The Extended System used in some ports of the Bay of Bengal to locate the position of the Storm. For this purpose the Bay is divided in six sections. The component parts of all the visual signals are explained in appendix 2.13 in table 2.61 of paragraph 2.354. During the day visuals consist of drums of 4' diameter and length 2', the other 2' diameter and length 4' 4', cones of base 4' diameter and height 4' and combination of cones placed base to base (diamond) or vertex to vertex (hour of lass), each of diameter 2.5' and height 2.5'. The height visuals employ lamps white and red lamps. The warnings are essentially based on three stage classification of the storm : Squally weather : Mean wind speeds upto 60 km/hr, wind gusty accompanied by rain, storm of slight/moderate intensity and storm of great intensity. The Committee recommended** :

CRC/87 : The visual storm signals demonstrated at the sea ports should directly be correlated to the three classifications of cyclones : Depressions (32-50 kmph), Toofan (51-89 kmph) and Severe Toofan (89 kmph and above).

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* IMD Cyclone Manual : Chapter -9
Weather Services to shipping, fishing vessels and marine interests : IMD(1974)
Code of Storm Warning signals for use at Indian Maritime ports : IMD (revised upto 1979)

** As mentioned in footnote to paragraph 2.142 IMD did not accept this classification of storms recommended in CRC/79).

2.152 METEOROLOGICAL SERVICES FOR MERCHANT VESSELS AND COASTAL BOATS* :

Weather information issued by the IMD for broadcast of specific interest to ships and other maritime traffic are available in two forms :

1. Sea bulletins
2. Coastal bulletins

Both bulletins are broadcast in morse code by WT from P&T coastal radio stations (tables 2.63 & 2.66) appendix 2.14 paragraphs 2.355 and 2.358 on frequencies normally used by ships. The bulletins are in four categories:

Daily : In normal weather they are broadcast twice daily at fixed hours.

Extra : In the event of disturbed weather this is broadcast at fixed hours. When a depression has formed, this bulletin is invariably broadcast.

Storm : When a cyclonic storm has been formed, three storm bulletins are broadcast daily at fixed hours.

Special : If any unexpected development of weather warrants urgent communication to ships, this is broadcast at any time deemed necessary.

2.153 SEA BULLETINS** :

These bulletins are broadcast by the P&T coastal radio stations at Bombay (call dsign VWB), Calcutta (VWC) and Madras (VWM). The bulletins for the Arabian sea broadcast from Bombay are issued by ACWC-Bombay, while those for the Bay of Bengal are issued by ACWC-Calcutta and ACWC-Madras. In accordance with the regulations laid down by WMO and as desired by the International Convention of Safety of Life at Sea (1960) the bulletin consists of six parts :

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* IMD Cyclone Manual : Chapter 9
Weather Services to shipping, fishing vessels and marine interests : IMD (1974)
Code of Storm Warning signals for use at Indian Maritime ports : IMD (revised upto 1979)

** IMD Cyclone Manual : Chapter 9
Weather Services to shipping, fishing vessels and marine interests : IMD (1974)

Part I : Storm warning in plain language

Part II : Synopsis of weather conditions in the forecast area in plain language

Part III : Forecast in plain language

Part IV : Analysis of surface synoptic chart in IAC Fleet Code

Part V : Observational data from ships and selected

Part VI : A selection of reports from land sections (surface and upper air reports in WMO codes).

Table 2.63 in appendix 2.14 (paragraph 2.355) gives the timings and broadcast frequencies of weather bulletins to ships from various coastal P&T stations.

2.154 COASTAL BULLETINS* :

To meet the requirements of ships plying close to the coast and to furnish them in greater detail, weather information in coastal areas, broadcasts of coastal bulletins for merchant shipping was started in 1964. As in the case of sea bulletins for merchant vessels the coastal bulletins are broadcast from the P&T coastal radio stations in morse codes and are mainly directed to coastal shipping. Just as is done for sea bulletins, the coastal bulletins are also broadcast as Daily, Extra, Storm and Special coastal bulletins for coastal strips under similar conditions. For the purpose of these bulletins the coastal area is defined as the sea upto 73 km off. The contents of the coastal bulletins are informations on :

1, Name of the coastal ship

2. Details of important weather system, if any, affecting the weather over the coastal ship and its movement in cases of Extra/Storm bulletins

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* IMD Cyclone Manual : Chapter 9
Weather Services to shipping, fishing vessels and marine interests : IMD (1974)

3. Period of validity of the forecast
4. Forecast of wind, weather, visibility and state of sea for the coastal ship
5. Information about storm warning signals, if any, hoisted at ports on the coastal ship
6. Information of storm/surges tidal waves given as when necessary.

Table 2.66 in appendix 2.14 (paragraph 2.358) gives the P&T coastal radio stations from which coastal bulletins are broadcast and the timings and frequencies.

2.155 COASTAL WEATHER BROADCASTS BY AIR* :

Since 1969 whenever a cyclonic storm is likely to affect the Indian coastal areas, coastal weather bulletins issued by the IMD are broadcast in the AIR News Cycle in English and the regional language of the affected area. The bulletins contain informations on

1. Time of issue of bulletin in IST
2. Coastal strip for which bulletin is issued and period of validity
3. Position, intensity and movement of cyclonic storm
4. Forecast of winds and state of the sea and waves
5. Signals hoisted at the ports in the coastal ship
6. Information of storm surges/tidal waves

The AIR stations in the coastal states that broadcast these weather bulletins have been listed in table 2.68 - Appendix 2.15 (paragraph 2.360).

IV.C(3) DISSEMINATION OF CYCLONE WARNINGS

IV.C(3.1) CYCLONE WARNING DISSEMINATION (CWD) BY P&T TC CHANNELS

2.156 PRIORITY CODES FOR CYCLONE WARNINGS BY LAND LINE TELEGRAMS (LLTs)* :

The Cyclone Warning System is at present based mainly on the land line telegrams, the part of the system which is

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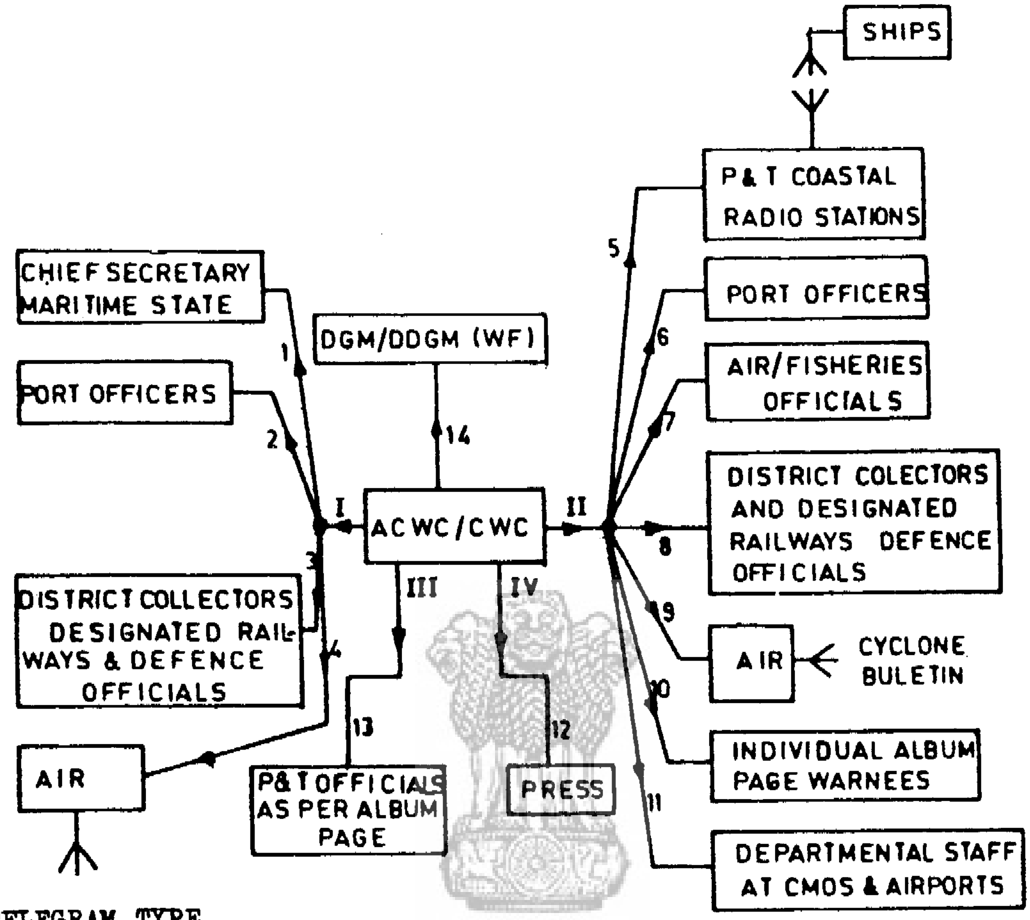
* Working paper No. 20 placed before the Committee by the IMD


SHIPS
P& T COASTAL RADIO STATIONS
5
PORT OFFICERS
6
AIR/FISHERIES OFFICIALS
7
CHIEF SECRETARY MARITIME STATE
1
DGM/DDGM (WF)
14
PORT OFFICERS
2
I
ACWC/CWC
II
DISTRICT COLECTORS AND DESIGNATED RAILWAYS DEFENCE OFFICIALS
8
3
III
IV
DISTRICT COLLECTORS DESIGNATED RAILWAYS & DEFENCE OFFICIALS
4
9
AIR
CYCLONE BULETIN
10
13
12
AIR
P&T OFFICIALS AS PER ALBUM PAGE
PRESS
INDIVIDUAL ALBUM PAGE WARNEES
11
DEPARTMENTAL STAFF AT CMOS & AIRPORTS

TELEGRAM TYPE

I Code : 000 Weather Immediate (Highest Priority
II Code : XXW
III Code : XXT
IV Code : BGXQ

Message type

1.All CWM under the 2 Stage warning system
2.First advisory Danger/Great Danger Signals
3.All Cyclone warning messages excepting first advisory (2)
4.Special Cyclone Bulletin on emergency
5.Sea area/Coastal Weather Bulletins
6.All Port warnings except first advisory(2)
7.Fisheries warnings
8.First Stage Cyclone messages except those for Chief Secretaries
9.Cyclone waring bulletins
10 .Warnings
11.Copies of AIR Bulletins
12.Farmer's Weather Bulletin Containing Warnings
13.Warnings per specific requirement
14.All Copies of 000 Telegrams

Ψ =Radio Broadcast
CWM = Cyclone Warning Message

Fig.2.28 : P&T land line telegram channels for cyclone warning service (OWS). Reference 27.

the oldest. The telegram codes used are 000 (Weather Immediate), XXW, XXT and BGXQ. The list of Warnees has been given in Table 2.24. 000 and XXW are the high priority classification i.e. the delivery of telegrams must be made within 45 minutes. Unfortunately the experience has been that this priority is often not honoured. During the 1982 Orissa Cyclone failure to maintain this priority for 000 telegrams left the Paradeep unprepared to meet the incoming cyclone.

2.157 THE USE OF CYCLONE WARNING TELEGRAMS (CWTs) WITH PRIORITY CODE 000* :

The highest priority 000 coded land line telegram (Weather immediate) is used very sparingly, carefully and judiciously. At ptesent it is used for the following purposes :

1. Cyclone Warning First Stage Message 'Cyclone Alert' to Chief Secretary of the affected state
2. Warnings to Port Officials advising hoisting of Danger and Great Danger Signal for the first time
3. Cyclone Warning Messages from the second stage 'Cyclone Warning' onwards to the District Collectors and designated Railway and Defence Officials
4. All warning telegrams issued under the two stage systems to the Chief Secretary of the cyclone affected state
5. Also when information about cyclone to be transmitted is of major importance. Thus Special Cyclone Bulletins are transmitted under this code on crucial occasions. The Meteorologist in charge of the ACWC/CWCs decide the use of this priority on all such special occasions.

The 000 telegrams are personally handed over by the ACWC/CWC assistant to the Weather Telegraph Office (WTO) who is responsible for their immediate transmission. A list of 000 telegrams messages despatched are sent to DDGM(WF) and DGM of the IMD as statement of the final report of the cyclone.

2.158 THE USE OF CWTs WITH PRIORITY CODE XXW* :

The next high priority telegram is covered under the code XXW. This code is used for the following purposes :

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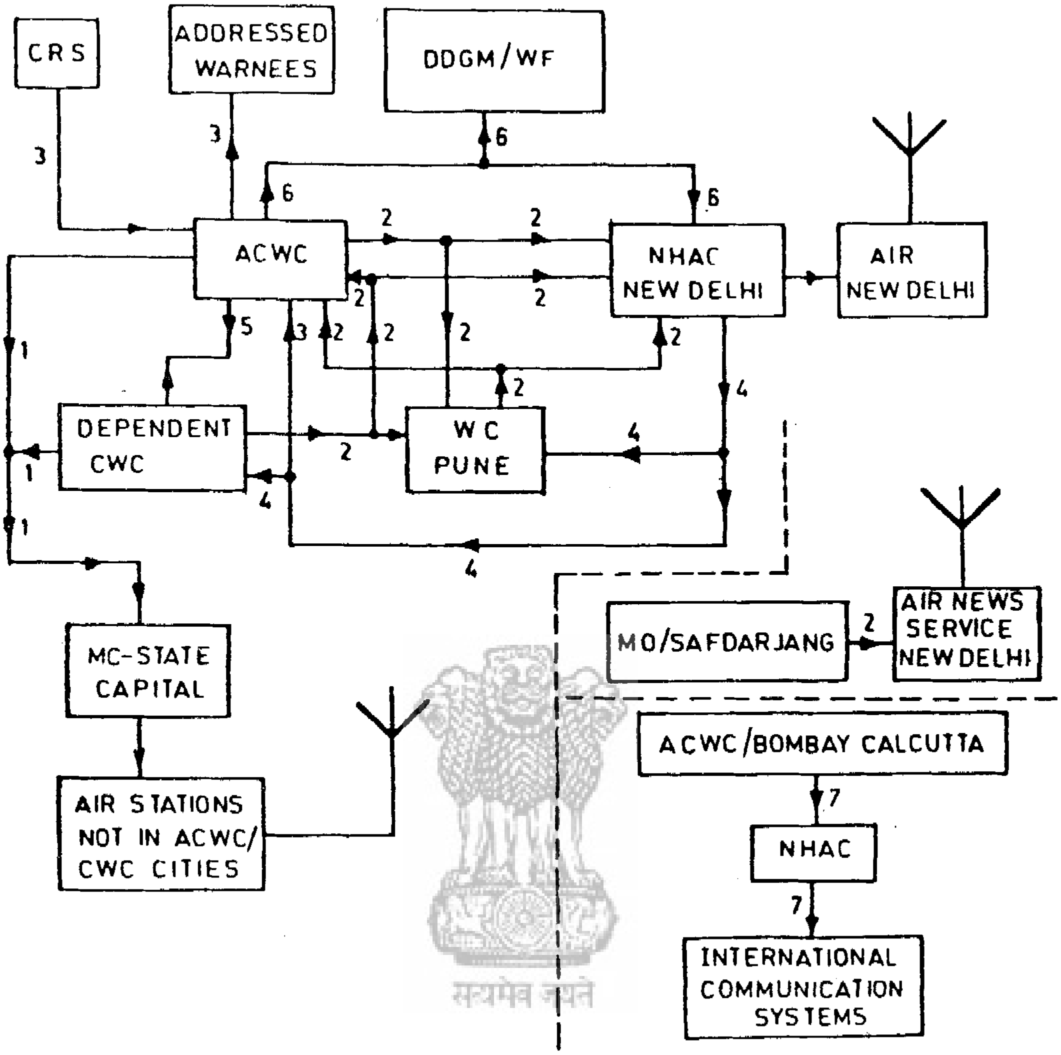
* IMD : Working paper 20 put before the Committee



Links : TP linkage under OU/OI priority

Types of Messages

1. Cyclone Warning Bulletin
2. Coastal Weather Bulletin
3. Part A of Cyclone Warning Radar Report
4. Storm Surge Advisories
5. Directives, Advisories, Informatory, Messages, Warning
6. Copies of Press Bulletin
7. Cyclone Warnings for Arabian Sea/Bay of Bengal

Legend

ACWC/CWC = Area Cyclone Warning Centre, Cyclone Warning Centre

CWR = Cyclone Warning Radar

DDGM/WF = Deputy Director General Weather Forecasting

WC = Weather Central

MO = Meteorological Office

NHAC = Northern Hemisphere Analysis Centre

= Radio Broadcast

Fig.2.29 Meteorological TP channels for CWS-TP links under OU/OI priority. Reference 27,28

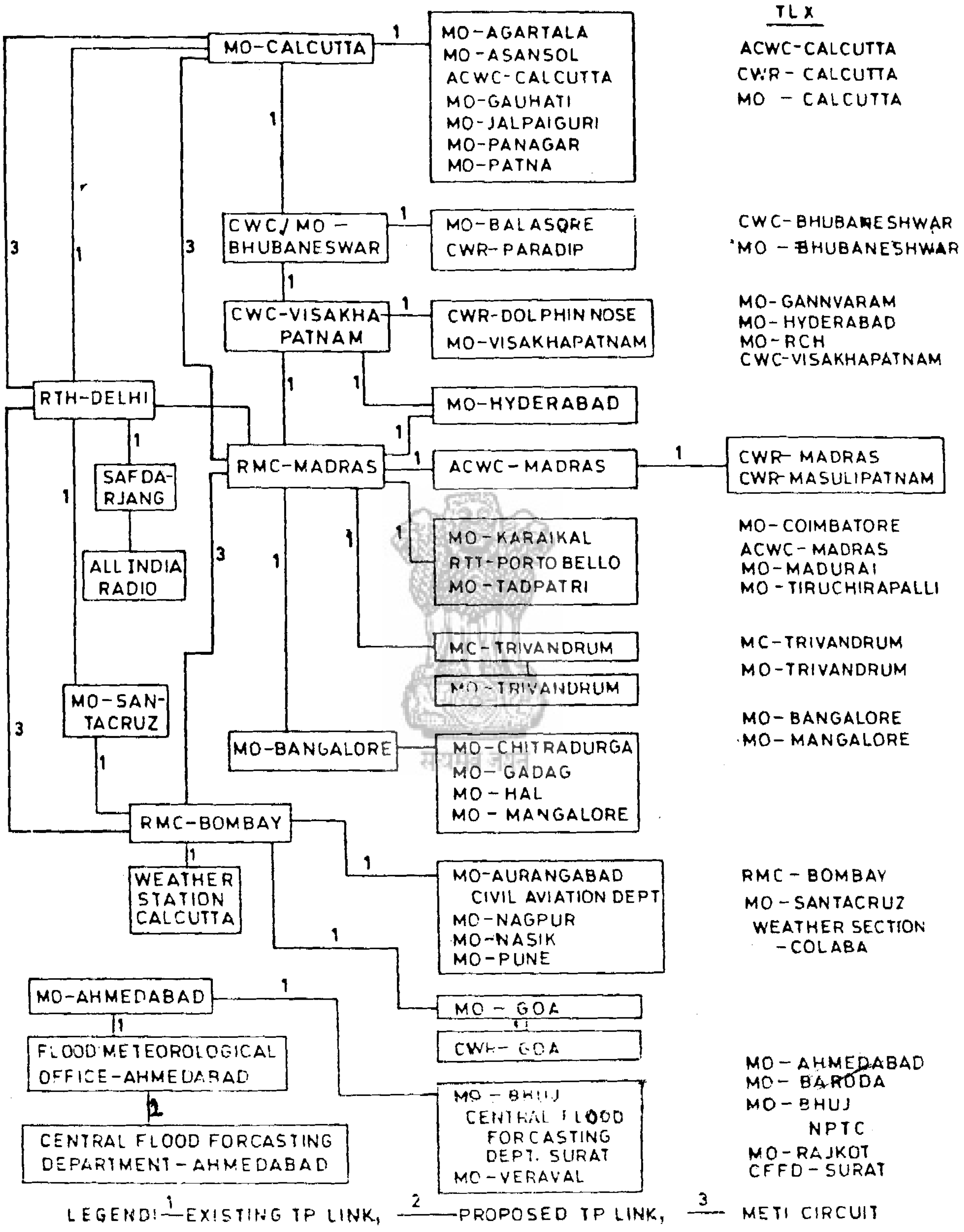


Fig.2.30 IMD TP network in coastal India. Reference 27

1. Sea area bulletins and coastal weather bulletins to P&T coastal radio stations for broadcast to shipping.

2. All port warning except the first advisory to hoist Danger or Great Danger signals which is covered by telegrams under the 000 code.

3. Fisheries warnings to AIR stations and individual fisheries officials listed on the album pages.

4. The First Stage Cyclone Warning 'Cyclone Alert' to all warnees except the Chief Secretary of the Cyclone affected state, who is warned by a 000 telegram.

5. Cyclone Warning Bulletins to AIR.

6. Warnings to all album page warnees.

7. Copies of AIR bulletins sent to departmental staff in coastal observatories and airports.

2.159 THE USE OF CWTs WITH PRIORITY CODES XXT/BGXQ* :

XXT coded telegrams are used to warn some officials of the P&T department on the warning lists of the ACWC/CWCs individually according to their requirements. Farmer's weather bulletins are sent to the Press by telegrams coded BGXQ.

2.160 EXTENDED WORKING HOURS OF P&T STAFF IN THE WEATHER TELEGRAPH OFFICES (WTOs) AT THE ACWC/CWCs DURING CYCLONES :

Each ACWC/CWCs are served by a telegraph office which is located in the same buildings in which it is located for facilitating quick transmission and reception of messages. The watch hours of these telegram offices are generally those of ACWC/CWCs. During periods of weather disturbances, depressions and storms, when round the clock watch is maintained at the ACWC/CWCs, these telegrams offices are requested to extend their working hours by special written requisitions. The resulting overtime allowance incurred by each extension of working hours of these WTOs are borne by the IMD.

2.161 DEPARTMENTAL TELEPRINTER (TP) CHANNELS OF THE IMD AND THEIR USE FOR CYCLONE WARNING DISSEMINATION (CWD)* :

IMD departmental teleprinter channels are extensively used to disseminate Cyclone Warning Messages. The TP channels of the IMD available for the CWS, linking the various units of the system, are shown schematically for the following purposes.

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* IMD : Working paper 20 put before the Committee.

1. To exchange between departmental offices under priority OU/OI : Sea area bulletin, tentative aurora, India weather bulletin, and regional inferences. Whenever TP channels exist these messages are distributed to Naval and Air Force Meteorological Offices.

2. To transmit from the ACWCs at Bombay and Calcutta, by TP channels under close OU, warnings for the Arabian Sea and the Bay of Bengal respectively. to the NHAC for international exchanges.

3. Transmission of Cyclone Warning bulletins to the AIR stations not located at the ACWC/CWCs by departmental TP channels under class OU, by these centres : first to the concerned MCs at the State Capitals who in turn pass on the bulletins to the AIR stations by telephones.

4. Transmission of Coastal Weather bulletins during a cyclone regime by the departmental TP channels, classed OU.

   (a) from the CWCs to the ACWCs, WC-Pune and NHAC-Delhi

   (b) from the ACWCs to WC-Pune and NHAC-Delhi

   (c) from the WC-Pune to NHAC-Delhi for inclusion in the news cycle from AIR New Delhi.

In case of failure of the TP channel, the bulletins and the warnings have to be sent by telex or land line telegrams coded 000 or XXW or trunk telephones for the information to reach Delhi to time to be included in the respective AIR news cycle broadcasts.

5. When the centre of the storm/depression can be estimated from the radar observations, Part A of the Cyclone Warning Radar report is sent by the departmental TP channel, as an addressed message, to specific addresses under high priority OU class. In case of failure of TP channels, the message is transmitted by the fastest available means of communication : Telex, VHF communication, Radio Telephone (RT), Messenger etc.

6. NHAC-Delhi sends storm surge advisories to the ACWC/CWC and WC-Pune by TP channels under classification OU.

7. The ACWCs sends copies of Press bulletins issued by them to the NHAC-Delhi and the DDGM (WF) by TP channels under classification.

8. All communications between a parent ACWC and the CWCs under its control regarding directives, advisories, informatory messages and warnings are sent by its TP channel under classification OU.

9. A special TP link exists between MO Safdarjang and the news division of AIR New Delhi for transmission of coastal weather bulletins for the AIR news cycle. In case of failure of TP channels the bulletins are sent either by telex or telephones.

2.162 USE OF TELEX IN CWD* :

Telex provides an important communication channel for transmission of Cyclone Warning Messages. All the RCCs, SCCs and the ACWC/CWCs are provided with the Telex facility as a back up for the land line TP links. A few departmental MOs are also provided with this facility for transmission of their observations to the associated SCC/RCCs. There are two categories of telex messages

1. those transmitted to the departmental offices

2. those intended for outside parties

The following types of messages normally transmitted on TP channels under OU class are sometimes transmitted also additionally over telex or when the TP channels fail :

1. Coastal news bulletins for AIR News Cyclone

2. Fleet forecast from ACWC-Calcutta and Indian Ocean and Southern Hemisphere Analysis Centre - INSHAC at Pune to MCC Bombay.

3. Sea area bulletins or bulletins for departmental exchanges during a critical cyclone situation.

4. During disturbed weather the APT bulletins from Bombay may also be sent to concerned centres by telex in case of failure of TP channels. The decision to do this is at the discretion of the Regional Director (RD).

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* IMD : Working paper No. 20 submitted to the Committee by IMD

For outside parties who have telex facilities, the messages are sent by this channel and acknowledgement received immediately. The following types of messages are sent

1. Fisheries warnings and cyclone bulletins to AIR stations with telex facilities exist there
2. All warnings under the two stage Cyclone Warning System to the Chief Secretary of the affected state
3. Coastal weather bulletins for AIR news cycle from Meteorological Office Safdarjung to AIR New Delhi.

2.163 USE OF TELEPHONES IN CWD* :

The last traditional channel for CWS is the telephone, local and trunk. Telephones are mainly used as a backup arrangement to telegram, TP and Telex. The following messages are transmitted through local telephones.

1. All two stage cyclone warnings to the Chief Secretaries of the affected State or to their PAs in case they can not be contacted. For metropolitan cities like Bombay, Calcutta and Madras the cyclone warnings during cyclone regimes are given telephonically to designated Senior Officials of Public Undertakings.
2. Cyclone Warning Bulletins to local AIR stations
3. Port warning to local ports and signal stations
4. Information regarding hoisting of signals at Tamil Nadu ports to the State Port Officer, Madras from ACWC-Madras
5. Fleet forecasts from ACWC-Calcutta to Signals Calcutta
6. Coastal Weather Bulletins from ACWC/CWCs to local Navy signals
7. Fisheries warnings to local AIR stations
8. Press Bulletins to local newspapers.

Trunk telephones are used for the following purposes :

1. Port warnings especially the first advice for hoisting Danger/Great Danger Signals by trunk calls - under class immediate during conditions of emergency

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* IMD : Working paper 20 put before the Committee.

2. All two stage warnings during critical situations to coastal collectors

3. Cyclone Warning Bulletins to AIR stations during exceptional situations such as when break down of all cummunication channels is apprehended

4. Passing of vital information to other departmental offices for mutual consultation by turn calls - under class Fixed Time.

2.164 NEED FOR DIRECT TC LINKS BETWEEN THE OFFICE OF THE CHIEF SECRETARY OF A COASTAL STATE, THE CYCLONE CONTROL ROOMS (CCRs) AT THE DISTRICT HEADQUARTERS AND THE CONCERNED ACWC/CWCs :

The exisitng traditional communication system utilised for dissemination of CWMs was found by the Committee on the face of it, adequate subject of course to the uncertainties and failures caused by the cyclone themselves. The Committee noticed however that all the ACWC/CWCs were perhaps not connected by reliable TC channels to Secretaries of the coastal statesaand to the district headquarters in cyclone prone areas. For the purpose of immediate dissemination of CWMs and executing emergency measures, such links are of the highest importance.

2.165 NEED FOR IMPROVED TC LINK BETWEEN THE AIR/P&T RADIO STATIONS IN THE COASTAL STATES AND THE CONCERNED ACWC/CWC :

It has been suggested that for quick transmission of CWMs to the AIR stations for further broadcast, the ACWC/CWCs should be connected to the AIR stations at the coastal State Capitals by TP channels and Telex. These centres should always be in communication with printed messages to avoid any error in transmission. At present the CWMs are sent as telegrammed messages; and it is felt that more reliable TC channels are required.

2.166 SUGGESTION FOR IMPROVEMENTS OF THE P&T TC CHANNELS USED FOR CWD* :

The Committee noted the proposal of the IMD (IMD-CP/6) to

1. establish facilities for transmission of pictures from CWRs to the appropriate ACWC/CWCs by landline facsimile transmission system when such units are not located at the same place. The Committee has made a recommendation CRC/22 in this matter (III.A(5).3 Paragraph 2.54)

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* IMD CP

2. establish departmental WT or TP and/or Telex communications between 50 additional observatories/CMOs to expedite quick collection of data. The Committee has discussed this matter in IV.B(5) paragraph 2.127.

The Committee also endorsed IMD proposal in its 6th Five Year Plan to enhance the speed of TP channels and to instal message switching computers at the Airports. During the third meeting of the CRC there was detailed discussions about the possibilities of improvement of communications over the P&T TC links used for CWD. In the light of the discussion on the items of Paragraphs 2.164-6 the Committee recommended :

CRC/88 : The first stage cyclone warning signal - 'Cyclone Alert' must be sent by the concerned ACWC/CWC to all cyclone warnees by land based telegrams. It is important to ensure that this warning is transmitted to the Chief Secretary of the affected state without any wastage of time by Weather Immediate telegrams, which bear the priority code 000 and also be telephone so that the Cyclone Code (CC) can be put into operation immediately. The AIR, being the organisation ultimately responsible for dissemination of Cyclone Bulletins (CBs) containing Cyclone Warning Messages (CWMs) and the Cyclone Advisories (CAs) to all cyclone warnees and the affected public, should be able to get the CBs at the topmost priority from the concerned ACWC/CWC on the fastest TC channel available. The P&T Department must ensure that the communication links from the concerned ACWC/CWC to the office of the Chief Secretary and the AIR stations do not snap in a cyclone emergency, or if they do, the P&T Department should repair/restore the communication link immediately or set up alternative TC links so that dissemination of the CBs is not interrupted/impeded.

CRC/89 : Though the ACWC/CWCs must make all attempt to disseminate the CBs containing the CWMs and the CAs to all cyclone warnees by whatever means that is available in a cyclone emergency as expeditiously as possible, it may be quite possible that it fails in doing this task because of the snapping of some TC link. After the first stage 'Cyclone Alert' signal has been received on the normal TC links from the concerned ACWC/CWC which will be generally possible because this signal will be issued quite some time before the cyclone arrives, the cyclone warnees should be advised to rely more on the CB broadcasts of the AIR for the latest upto the hour informations/advisories about the cyclone. The affected population should be advised that the CBs broadcast by the AIR are the only reliable informations about the cyclone that are available.

CRC/90 : Since the land line telegram (LLTs) are a vital part of the Cyclone Warning Dissemination System and since the general experience is that the cyclone warning telegrams (CWTs) often fail to reach the warnees in the stipulated time not with standing the priority codes marked on them, the P&T Department should examine the problem and remove the lacunae of the system and ensure that the communication system works efficiently. During the cyclone regime standby hot lines should be provided by the P&T Department between the ACWC/CWC,AIR, office of the Chief Secretary of the affected State, Cyclone Control Rooms at the district headquarters and at the P&T coastal radio stations.

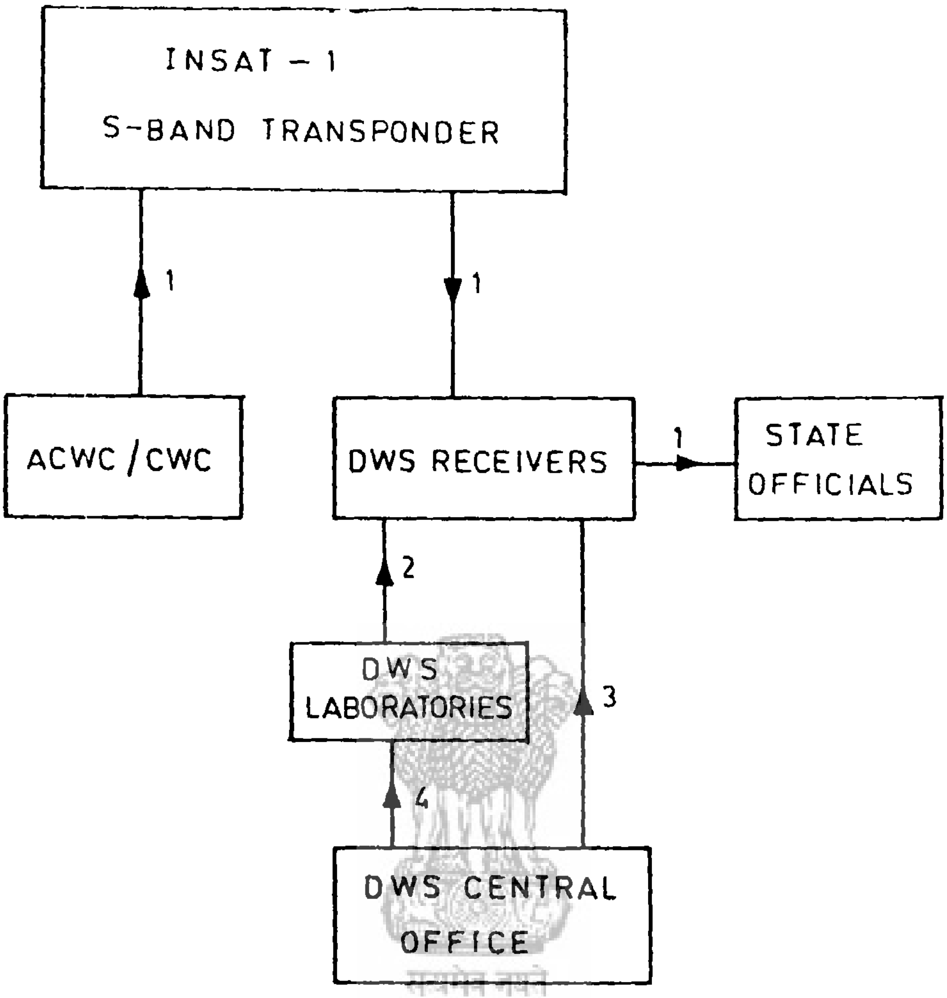
2.167 NEED FOR DIRECT TC LINKS BETWEEN THE FLOOD FORECASTING CENTRES, SECRETARIAT OF THE IRRIGATION DEPARTMENT IN A COASTAL STATE AND THE CONCERNED ACWC/CWC :

The inundations caused by cyclones are not only caused **by** storm surges from the sea but also from sudden release of water from river dams near to the coast because of heavy precipitation caused by cyclones. The state of the water standing at low regions on the coast prior to the landfall of the cyclone has also to be considered ato assess the degree of possible inundations and formulate emergency measures. The Committee endorsed the recommendations of CDMC (CDMC/30) in this connection :

CRC/91 : The ACWC/CWCs should establish close liason with the different Flood Forecasting Centres of various agencies in the State for prompt exchange of warnings so that they are in a position to assess the cumulative effect of the already standing waters and floods and the cyclonic storm surge, and then to utilise the data for the subsequent warnings. For this purpose it is essential that relaible TC channels are established between the ACWC/CWCs, the Flood Forecasting Centres and the Secretariate of the Irrigation Departments in the coastal states of India.

2.168 STANDING INSTRUCTIONS FOR MAKING POLICE WT SYSTEM AVAILABLE FOR CWD IN CASE OF FAILURE OF NORMAL TC SYSTEMS :

It has been already mentioned in paragraph 2.128 that normally the Police WT is not available to transmit weather informations from the coastal/island MOs to the ACWC/CWCs and the collection centres because of the very heavy pressure of the routine work of the Police authorities. But during a cyclone regime while facing conditions of extreme emergency, when perhaps the normal communication channels might have failed, the Police WT may be the only channel left for dissemination of CWM messages from the ACWC/CWCs to the various agencies/warnees, specially the AIR which is the chief agency to broadcast the warnings to the public and for the execution of evacuation and relief measures. The **Committee** recommended :



Linkages

1. Cyclone Warning Massage
2. Maintenance
3. Procurements / Installation
4. Administrative Control

Locations

ACWC/CWC: Bhubaneswar, Bombay, Calcutta, Hyderabad Madras.

DWS Central Office : At Satellite Meteorological Directorate at New Delhi.

Fig.2.31 : Proposed INSAT Disaster Warning System (DWS). Reference 26.

CRC/92 : There should be standing orders by all coastal State Governments, that their Police WT system is put at the disposal of the concerned ACWC/CWC without any loss of time for CWD work if such a request is made by the latter to the Chief Secretary of the State during a cyclone emergency.

2.169 NEED FOR IMPROVED TC LINK BETWEEN ACWC-CALCUTTA AND THE CWC-DHAKA FOR BETTER CWD IN NORTHERN COAST OF BAY OF BENGAL :

The Committee felt that there should be reliable TC channels between India and its immediate neighbours Bangla Desh on east and Pakistan on the west. The main Trunk Circuit of the Global Telecommunication System at the RTH has been already described in paragraph 2.105. This establishes connection of Delhi with Dhaka and Karachi. The Committee however felt that it would be useful to have RTT communications with the Storm Warning Centres in Bangla Desh and ACWC-Calcutta to exchange weather informations collected by ships in the Bay of Bengal and the CWRs in the two countries and improve the CWD between the two countries. There exists already a TP connection between ACWC-Calcutta and the Dhaka Storm Warning Centre. It was noted that Bangla Desh was not agreeable to the proposal of establishing a RTT link with ACWC-Calcutta. At the suggestion of Bangla Desh a direct TP link has been established between Dhaka and New Delhi.

IV.C(3.2) CWD THROUGH THE INSAT SYSTEM

2.170 THE INSAT DISASTER WARNING SYSTEM (DWS)* :

One of the important components of the INSAT Meteorological Application Programme, approved by the Government of India, is the installation of Disaster Warning Receivers in areas liable to be frequently affected by adverse weather for receiving the warnings directly. The INSAT Coordination Committee (ICC) of secretaries approved of limited experimental implementation covering narrow coastal strips in Andhra Pradesh and Tamilnadu extending from Krishnapatnam to Chidambaram where 100 Disaster Warning System (DWS) receivers will be installed specially dedicated to cyclone warning. The system will provide a dependable and complementary cyclone warning system to supplement the existing other TC systems of the CWS and will cover the eventualities when the normal TC systems are snapped by the cyclones. Essentially the DWS system would be a communication system between the ACWC/CWCs and the concerned State Government Officials, who are on the warnee list, via INSAT utilising the laters S-band capability and TV broadcasting system onboard described in paragraphs 2.112 and 2.113. The DWS scheme is shown schematically in fig. 2.31. It is envisaged to have initially 400 DWS receivers in the CPARs. The project is now at an advanced stage of planning. The operational installation activities of this project are due to start in the middle of 1983. The uplink communication facilities will be provided by the P&T department at the ACWC/CWCs, which would generate the CWMs for dissemination. Under the DWS scheme the CWM originating by the ACWC/CWC is transmitted by the earth station of the P&T department to INSAT which in turn rebroadcast it to the areas likely to be affected. The DWS signal transmitted by INSAT would be intercepted directly by the receivers located in these areas. It is also proposed that the IMD will provide a DWS Central Office at the Satellite Meteorological Directorate at Delhi and DWS laboratories at Bombay, Bhubaneswar, Calcutta, Madras and Visakhapatnam. The DWS Central Office may have a Director and 20 officers and the responsibility would be to :

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* IMD Working paper 19 put before the Committee CMAS : Notes on agenda.

1. plan the DWS organisation
2. procure DWS receivers with their spares
3. provide training to the DWS personnel working in the regional DWS laboratories and the staff operating the DWS receivers.

The regional DWS laboratories would be manned by two technical officers and 12 technical staff. The responsibility of these laboratories would be :

1. maintenance of DWS network
2. periodical inspection for maintenance and repair of 400 DWS receivers which are scattered over the east and the west coast of India.

It was also stated that while the maintenance and repair of the DWS receivers would rest with the regional DWS laboratories and with the IMD, the task of day to day operation of the receivers must rest with the coastal State Governments. Work has started to establish first the DWS laboratory at Madras at the Regional Meteorological Centre (RMC) there. The IMD has placed a firm demand with the P&T Department for the provision of an uplink facility at the Madras Earth Station for the transmission of warning signals at ACWC-Madras. Space Application Centre (SAC)-Ahmedabad has designed/developed the prototype model of the DWS receiver which will be produced by a public sector undertaking. If the DWS functions well, the IMD will have an efficient reliable and real time system for CWD. It was also noted that in Orissa a network of 28 Police WT stations was being established under the DWS system. The Committee recommended :

CRC/93 : The Disaster Warning System (DWS) part of the INSAT programme should be established as early as possible to provide an alternative cyclone proof TC link between the ACWC/CWCs and the cyclone warnees.

CRC/94 : The responsibility of providing the DWS receivers and their repair and maintenance must rest with the IMD. But the responsibility of daily operation of these instruments must rest with the concerned coastal State Government.

CRC/95 : It would be very useful to link up the Police WT system with the DWS system to disseminate CWMs and advisories for evacuation, rescue and relief (ERR) operations during a cyclone regime.

IV.C(3.3) CWD THROUGH ALL INDIA RADIO (AIR)/ DOORDARSHAN

2.171 CWD BROADCASTS BY AIR :

It has been stated in paragraphs 2.98, 2.158, 2.161, 2.162 and 2.163 that CWMs are sent by the ACWC/CWCs to the concerned AIR stations in the states either by landline telegrams, TP channels, Telex, Telephones and in exceptional circumstances when the normal TC channels snap under onslaught of cyclones, by the Police WT. The CWMs are sent to the AIR stations 5 to 6 times a day. It was stated that the cyclone warnings via AIR did not always receive a high priority. On the other hand it was also mentioned that the 'Dewarning' messages are not always received at the AIR causing inconvenience. The Committee recommended :

CRC/96 : The first stage 'Cyclone Alert' warning signal should be broadcast 5 to 6 times daily as now, but when the cyclone has crossed into the CRH, the subsequent cyclone warnings should be broadcast hourly or half hourly round the clock for the benefit of listeners living in the areas where the landfall is expected (areas of Danger and Great Danger (AsD/AsGD)). There should be more complete and upto the hour CBs broadcast from this stage onwards containing CAs from the State Authorities regarding precautionary measures to be taken by the public and evacuation/rescue/relief (ERR) decisions progressively taken by the State authorities.

2.172 CYCLONE 'DEWARNING' SIGNAL AFTER COLLAPSE OF A CYCLONE :

It is important that the cyclone affected people is informed as early as is advisable that the cyclone had weakened and was harmless. Of course the cyclone monitoring system must provide sufficient evidence that the cyclone would not back track to the sea and again threaten the coast. This warning message should also be broadcast by AIR to reach as large cross section of the affected population as early as possible. The Committee recommended :

CRC/97 : After the cyclone has lanfalled and weakened the ACWC/CWC must as soon as possible issue the 'Cyclone Dewarning' message to the AIR stations for broadcast to the public.

2.173 BROADCAST BY AIR OF ADVISORIES REGARDING EVACUATION/RESCUE/RELIEF/REHABILITATION MEASURE (ERRRM) FOR CYCLONE VICTIMS :

Rescue, Relief and Rehabilitation starts after the cyclone has subsided. It has been already recommended (CRC/88) that all relevant CAs should be broadcast to the public by AIR. The Committee emphasised the need once again in the following recommendation.

CRC/98 : After the cyclone is over, the AIR stations should continue to broadcast as long as necessary, the CAs of the concerned State authorities regarding evacuation, rescue, relief and rehabilitation (ERRR) measures taken by the State authorities.

2.174 AIR NEWS CYCLE/COASTAL BULLETINS :

The coastal bulletins of the ACWC/CWCs are also routed through WC-Pune and NHAC-Delhi to AIR-Delhi for broadcast in the Home News Service. These bulletins cover different coastal belts and are in Hindi, English and the local languages. The broadcasts are thrice daily (morning, midday and night). The list of frequencies and the timings of the local language broadcasts in the short wave which are relayed and broadcast also in the medium frequencies assigned to the local AIR stations, are given in table 2.71 and 2.72 (paragraph 2.263-2.264 in appendix 2.15. The Committee recommended :

CRC/99 : When the cyclone has crossed the CRH, the frequency of broadcast of fishery warnings and coastal weather bulletins should be increased. It would be desirable to broadcast these warnings not only in the regular Home News Service of AIR in the regional languages of the coastal states but also, as and when necessary, from the local AIR stations in the affected states in the languages of the local speeches, 'Nil Warning' messages should be broadcast as usual.

2.175 STORM SURGE/FLOOD WARNING BROADCASTS BY AIR :

During the flood season it is the task of the AIR to issue flood bulletins (FBs) in addition to their usual news bulletins, with the frequency of the bulletins increasing as the threat potential of floods increases. During the actual flooding special FBs are broadcast indicating the extent of the inundation of towns and villages likely to be affected. Advisories about evacuation/rescue/relief (ERR) and instructions to the various organisations expected to carry out the ERR operations in various flooded localities are also notified by broadcasts over the AIR. The storm surge warnings are contained in the CBs broadcast by the AIR.

2.176 SPECIAL WARNINGS BY AIR FOR FISHERMEN/FISHING BOATS* :

The ACWC/CWCs issue special warnings for fishing interests whenever wind speeds exceed 45 kmph (25 kt) (squally weather, gales, strong monsoon, and offshore winds) and wave heights are expected to be 4-5 meter or more upto a distance of 75 km from the coast. These warnings are transmitted by land line telegram or telephone to the appropriate AIR radio stations in the coastal states for broadcast in local languages thrice a day (morning, midday and evening). AIR-Bombay broadcasts also in the night. During cyclones such warnings are covered in the cyclone bulletins sent hourly or three hourly to the AIR stations for frequent broadcasts. More details about these broadcasts are given in table 2.67 of appendix 2.14 (paragraph 2.359). The fishermen are expected to listen with transistor radios. This table also gives the frequencies and the schedule of broadcasts of warnings to fishermen. A recent concept** for the Cyclone Code* in the interest of fishermen who belong to the low income group and lack the sophisticated education needed to comprehend the utility of the warnings issued in their interests is creation of small meteorological liason units for serving this group. The proposal is to establish two centres in the eastern and southern maritime states. The casualty among the fishermen in the event of a cyclone is generally quite heavy. The Committee therefore recommended :

CRC/100 : Meteorological Liason Offices should be established at important fishing centres to interpret to the fishermen/groups of fishermen/fishermen colonies/fishing cooperatives about the significance of the cyclone warnings issued by the ACWC/CWC over the AIR for fishing interests.

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* Weather Services to shipping, fishing vessels and marine interests : IMD (1974).

** IMD-CMAS : Notes on agenda of meetings

2.177 TRANSISTOR RECEIVERS FOR FISHERMEN/FISHING BOATS ON SEA :

The CDMC had recommended transistor radios for men out at sea and this Committee endorsed the recommendation (CDMC/23).

CRC/101 : It should be imperative for each or groups of fishing craft to carry suitable transistor radios for receiving the CWMs and the CAs. These may be provided/let out under hire to these users by the concerned State Governments.

2.178 FACILITIES FOR DESIGNATED OFFICIALS TO MONITOR AIR CB BROADCASTS :

It is expected that all AIR broadcasts of warnings after the first 'Cyclone Alert' should be monitored and heard by all the designated officials the State Administration like officials in the Chief Secretary's secretariate, District Collectors and also of the Central Government Departments such as the Defence, the Railways etc. The Committee recommended :

CRC/102 : Designated officials in the State and Central Governments should possess facilities to monitor the CBs broadcast by the AIR stations.

2.179 TRANSISTOR RECEIVERS FOR MONITORING AIR CBs IN THE RURAL AREAS :

The cheapest receivers which are most widely used by a very large section of the public are the transistor receivers receiving medium waves. The CDMC had recommended these receivers for certain designated officials and the Committee endorsed that recommendation (CDMC/22).

CRC/103 : For monitoring the CBs broadcast of AIR transistor radios should be provided to (1) designated officials of the coastal State and the Central Governments located in the rural areas and (2) to the Headmen of hamlets and village Pradhans of Gram Panchayats and Sarpanches, who are entrusted by the District Collector with the responsibility of disseminating CWMs and the CAs and various other tasks for protection of public life and property.

2.180 LANGUAGE OF CBs BROADCAST BY AIR :

For the public it is necessary to broadcast not only in Hindi and English but also in local language and this is done now from all the AIR stations. The details of schedule of broadcasts in regional languages in the AIR Home News

Service is given in Table 2.71 and Table 2.72 in appendix 2.15 (paragraph 2.363 and 2.364).

2.181 RANGE OF AUDIBILITY OF THE AIR STATIONS IN THE COASTAL STATES :

Evidently it is necessary to ensure that the AIR stations in the coastal states have sufficient power to cover all listeners in the coastal areas. The Committee recommended :

CRC/104 : The range of audibility of the AIR stations in the coastal states should be reviewed periodically to the extent possible, to ensure that it is possible for all listeners in the CPARs on the coast to receive clearly the CB broadcasts.

2.182 ROUND THE CLOCK BROADCAST OF CBs BY AIR DURING CYCLONES :

When the cyclones crosses the CRH it may be necessary to broadcast the CBs round the clock by the AIR. This may cause administrative problems. The Committee recommended :

CRC/105 : After the cyclone has crossed into the CRH it may become necessary for the AIR to broadcast its CBs to the public round the clock. The necessary arrangements should be made by the authorities of this organisation.

2.183 SPECIFIC WARNINGS BY COASTAL P&T RADIO STATIONS : SEA BULLETINS AND FLEET FORECASTS* :

Weather and sea bulletins are for shippings on the sea and those plying in coastal waters. The bulletins for merchant ships are issued only by ACWC-Bombay and Calcutta, which are broadcast by P&T coastal radio stations at Bombay, Calcutta and Madras. Details are given in table 2.63 (paragraph 2.355) of appendix 2.14. Fleet forecasts are meant for the Indian Navy and are issued by the ACWC-Bombay for the Arabian Sea, by the ACWC-Calcutta for the Bay of Bengal and by the INOSHAC-Pune for a portion of the Indian Ocean. The fleet forecast warnings are broadcast from the Naval WT stations at Bombay and Visakhapatnam. The details are given in table 2.65 (paragraph 2.357) of appendix 2.14. The areas covered by fleet forecasts on the Arabian Sea and the Bay of Bengal are slightly larger than those for the merchant fleet.

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* IMD Cyclone Manual : Chapter 9
Weather Service for shipping, fishing vessels and marine interests : IMD (1974).

The forecasts for coastal shipping are issued by all the ACWC/CWCs for their respective areas of responsibility. However the forecasts for the Orissa coast is still made by 11 P&T radio stations. The details are given in table 2.66 (paragraph 2.358) of appendix 2.14. The sea bulletins for departmental exchange are also issued by all the ACWCs, by ACWC-Bombay for the Arabian Sea, by ACWC-Calcutta for the Bay of Bengal, and by ACWC-Madras for both Arabian Sea and Bay of Bengal only when the coast of the Madras region is threatened by disturbed weather.

2.184 BROADCAST OF SATELLITE PICTURES OF CYCLONES ON TV CHANNELS :

With the INSAT system it would be possible in course of time to monitor cyclones and telecast their pictures not only to the viewers in the cities but also to those in villages. It would produce a great impact to be able to follow the evolution of the cyclones and their motions with time from the telecast pictures. The Committee recommended :

CRC/106 : During a cyclone regime, the Doordarshan should show to the viewers satellite pictures of the evolution of the cyclone and its movement with time. After the cyclone has dissipated, the of time elapsed picture sequence of the cyclone should also be shown. This is for all viewers in the cities and the village communities. In this way it is hoped that a greater awareness will be created among the public about the nature/hazards of cyclones.

IV.C(3.4) CWD BY LIGHTHOUSES/LIGHTSHIPS

2.185 POSSIBILITY OF THE USE OF LIGHTHOUSES/LIGHTSHIPS FOR GIVING CYCLONE WARNINGS TO COASTAL WATER TRAFFIC :

There was discussion whether the numerous Lighthouses which have been erected on the Indian coast and the Light-ships could be used in CWS also. Under the Department of Light Houses and Light Ships there are about 128 Light houses on the Indian coast. The signals from the Light Houses are visible from far out in the sea and should be useful as signal stations for coastal vessels. Unfortunately it appears that there are international agreements on the responsibilities/signal systems for the Lighthouses/Lightships which cannot be easily changed. There did not seem to be any immediate prospects of utilising the Lighthouses/Lightships for cyclone warning. However the matter should be presented before the appropriate International bodies laying down practices for Lighthouses/Lightships.

IV.C(3.5) SPECIAL WARNINGS/WARNEES

2.186 SPECIAL WARNING TO SEAPORTS* :

The IMD maintains through the ACWC/CWCs a warning service for the Sea Ports by which the Port Officers are warned by 000/XXW coded telegrams (paragraph 2.157 and 2.158) 5 to 6 times a day during a cyclone, about the disturbed weather to be expected at their ports. The warning informs of the location, intensity, direction of motion of the storm and its anticipated landfall point and the time of landfall. If normal TC channel snaps, the Police WT system is expected to be used to convey the warnings. On receipt of the warnings the Port Officers hoist visual signals on signal masts so that they are visible from distance. These signals have been discussed in paragraph 2.151 and given in detail in table 2.62 in appendix 2.13 (paragraph 2.354). Mariners and other sea faring people including fishermen, who may not be literate, find these signals useful. Port Officers explain the warnings of the signals when called upon to do so. In some ports the meaning of the signals are prominently displayed in English as well as in the local languages. The Port Officers have their own arrangements to disseminate the warnings to the country boats and sailing vessels in the harbour. Table 2.26 gives the distributions of ports on the Indian coast which receive cyclone warning informations. Table 2.60 in appendix 2.13 (paragraph 2.353) gives the list of the Indian sea ports of various types. Fig. 2.51 in appendix 2.13 (Paragraph 2.353) gives their locations on the Indian coast.

TABLE 2.26

DISTRIBUTION OF PORTS ON INDIAN COAST RECEIVING CYCLONE WARNINGS/INFORMATIONS

State	East Coast					State	West Coast				
	EXT	GNL	BRF	SML	Total		EXT	GNL	BRF	SML	Total
1. Andaman Group	-	1	-	-	1	1.Goa	-	1	-	-	1
2. Andhra Pradesh	1	2	4	-	7	2.Gujarat	-	8	22	6	36
3. Orissa	-	2	2	-	4	3.Karnataka	-	3	5	6	14
4. Pondicherry	-	-	1	-	1	4.Kerala	-	4	8	-	12

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* IMD : Cyclone Manual - Chapter 9
Weather Services to shipping, fishing vessels and marine interests : IMD (1974)

	East Coast						West Coast				
State	EXT	GNL	BRF	SML	Total	State	EXT	GNL	BRF	SML	TOTAL
5. Tamil Nadu	3	3	2	1	9	5. Lakshadwip	-	-	1	-	1
6. West Bengal	1	3	-	-	4	6. Maharashtra	-	1	22	5	28
	5	11	9	1	26		-	17	58	17	92

Legend : EXT : Ports under Extended System i.e. which not only hoist all the 11 signals but also indicate the location of the storm

GNL : Ports under General System i.e which hoist all 11 signals. These ports are all on the Bay of Bengal

BRF : Ports under Brief System i.e. which hoist only 5 signals

SML : Small Ports which receive warnings from other ports but do not hoist signals.

2.187 SPECIAL WARNING - AVIATION :

These warnings are issued by the concerned Aviation Meteorological Office at the Airport on advice from the concerned ACWC/CWC.

2.188 PRESS BULLETINS :

Press bulletins are issued by the ACWC/CWCs during cyclone regimes to local newspapers for giving publicity to the warnings.

IV.C(3.6) PERIODIC TESTING OF THE CWD SYSTEM

2.189 ANNUAL MOCK TESTS OF THE CWD SYSTEM :

It is obvious that a system as complicated as the system for disseminating CWMs and CAs should be periodically tested to determine its efficiency and to strengthen any weak parts of any. It was reported that once a mock test was carried on to test the traditional channels of communication used for the CWMs and CAs, and it was found that CWM dissemination system needed much improvement. During the 1982 June Orissa Cyclone also the CWS seemed to breakdown completely leading to extensive damage to the Paradeep port. The Committee realised that such mock tests generate panic among the public, but it still felt that such tests on the Cyclone Warning Dissemination System (CWDS) are necessary. It recommended :

CRC/107 : To test the efficiency of the Cyclone Warning Dissemination System (CWDS), surprise mock tests should be carried out periodically by the IMD, P&T Department, AIR, State Government and various other agencies connected with CWD at least once a year during the noncyclonic seasons. The results of such tests should be utilised to remove any lacunae of the system and strengthen weak parts if any.

IV.C(3.7) CORRECT BALANCE AND DISCRETION IN THE MATTER OF CYCLONE WARNINGS

2.190 DISCRETION TO BE USED IN THE MATTER OF CYCLONE WARNING :

In issuance of warning against any disaster very great discretion should be used, as large number of officials of many agencies who have to be on the alert or in specific tasks in the disaster scene and large number of people living in the coastal areas are involved. Over warning should be avoided for if the warning is not borne out by actual reality people tend to ignore the warning system later. Under warning is also dangerous because it leaves people unaware and unprepared for the actual magnitude of the disaster to be faced. Thus the warning officers - at the ACWC/CWC and the Flood Forecasting Organisations must study the collected data/observations with very great care and use much discretion born of past experience before issuing the correct balanced warnings to the warnees.

2.V SUGGESTIONS FOR FORMULATION OF A NATIONAL CYCLONE CODE (NCC) AND A CYCLONE EMERGENCY ACTION PLANS (CEAP) FOR COASTAL STATES

2.V.A PRESENT STATUS OF CYCLONE CODES (CCs) IN THE COASTAL STATUS

2.191 NATURE OF THE CYCLONE CODE (CC) :

Any code is a collection/digest of laws that should be followed in an emergency. A National Cyclone Code (NCC) for the country would similarly be a body of laws, systems of derived rules/regulations, established standard practices/

principles to be followed in a cyclone emergency. It would form the basis for formulation of the Cyclone Emergency Action Plan (CEAP) for the coastal states. A code necessarily must have official sanction and should be mandatory and binding for the different government departments and officials to whom various tasks are assigned. It is conceivable many actions may come up to various court of laws. There is hardly any Cyclone Code in the country at present. There are few conventions and practices arising out of meteorological warnings and some procedures to mitigate the distress caused by cyclones arising out of the recommendations of the CDMC. Unless these principles are extended and legislated by the Central/Coastal Governments the country can not be said to have a National Cyclone Code (NCC). The Committee recommended :

CRC/108 : The Government of India should establish a National Cyclone Code (NCC) for the country by legislation in order that the coastal State Governments may use it for guidance for preparing their Cyclone Emergency Action Plan (CEAP) (Paragraph 2.191)

2.192 CYCLONE EMERGENCY ACTION PLAN (CEAP) FOR THE COASTAL STATES :

Each State has its own particular administrative ethos/practices, pecularities of coastal topography and special problems of the people living in the coastal regions and of the organisations located there. Thus there can not be a common CEAP for the Coastal States. Each State must work out its own form of CEAP under the constraints guidance of the NCC mentioned above and its own experience of cyclones. Once the NCC is established, it provides a broad basis for the State Governments to formulate their CEAPs and promulgate orders/instructions, frame rules/working procedures for measures for advisories/precautionaries/evacuation/rescue/relief/rehabilitation for the benefit of the public and special bodies of people and organisations located in the CPARs of the State.

2.193 CEAPs AS PART OF THE GENERAL DISASTER PLAN (GDP) OF A COASTAL STATE :

The CEAP must be part of the State General Disaster Plan (GDP) for the cyclone disaster has many features common with other kinds of disasters and need similar kind of measures to limit the loss of life and destruction of property and for mitigation of distress caused. Thus cyclone storm surges are similar to flash floods and dam bursts. In the wake of cyclones, the problems are also similar to those of other disasters like flood and famine at least so far as distributions of food, medicine and other relief through Refugee Camps are concerned. With respect to the rehabilitation aspect the problems are again similar to those for other disasters - floods and earthquakes etc. in as much as houses, roads, bridges etc. have to be rebuilt and the money and materials for these purposes found, agricultural fields have to be restored and seeds provided to farmers, fishing equipments - boats nets etc. have to be provided/repaired and so on. Thus the GDP has to contain integrated solutions for problems related to all kinds of disaster much of which will apply equally well to one type of disaster as to another.

2.194 FORMULATION OF CEAPs IN THE DIFFERENT COASTAL STATES :

In spite of the best efforts on the part of the Committee to find out whether the Coastal States have already formulated their CEAPs, the response was at first very disappointing. A prompt answer was obtained from the Tamilnadu Government only, who made its Anti Disaster Plan* available to the Committee. This GDP of Tamilnadu Government had a CEAP component in it which was considered by the Committee. Another elaborate CEAP for Andhra Pradesh Government** was received by the Committee by courtsey of Prof. P. Koteswaran and Prof. R.Ramanadham, members of the Committee. This plan has also been considered by the Committee for formulating principles for a NCC for the country. It was clear that some coastal State Governments have yet to establish the CEAPs/ The Committee recommended :

CRC/109 : The Coastal State Governments who have yet to formulate their Cyclone Emergency Action Plans (CEAPs) should do so as early as possible for laying down rules/ procedures for actions/measures to be taken in a cyclone emergency for mitigating the distress caused. The CEAPs may be based on the recommendations of the Committee with respect to a National Cyclone Code. The State CEAPs should be included as a Chapter in the State General Disaster Plan. The Coastal State Governments should publish their CEAP manuals for use by their officials during a cyclone emergency.

2.195 VERY LIMITED IMPLEMENTATION OF THE CDMC RECOMMENDATIONS FOR THE CYCLONE CODES IN COASTAL STATES :

The CDMC had already given a detailed model for a Cyclone Code which it named : A Model Cyclone Plan for a

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* Anti Disaster Plan, State of Tamil Nadu : Government of Tamilnadu (1978)

** Cyclone Contingency Plan of Action : Revenue Department, Government of Andhra Pradesh Hyderabad (1981).

Coastal Area in Andhra Pradesh*. The various coastal State Governments could have used this model for their Cyclone Codes. This was indeed recommended also by the CDMC (CDMC 48). The CDMC reports of the various coastal states reproduced in Chapter 7 also incorporate sketches of their CCs. It is not very clear how much of these CCs are put into practice during emergencies. The State of Andhra Pradesh and Tamilnadu do being their CCs into operation for the death toil in recent cyclones in these states have reduced.

2.196 SUGGESTIONS/RECOMMENDATIONS OF THE CRC FOR GUIDELINES FOR FORMULATING A NCC/CEAP :

This Committee makes recommendations which may be treated as guide lines to the coastal State Governments to improve further their Cyclone Codes. In making these recommendations the Model Cyclone Plan of the CDMC have been kept in view and the Contingency Cyclone Action Plan of Andhra Pradesh and the Anti Disaster Plan of Tamilnady have also been closely studied.

V.B CYCLONE DISTRESS MITIGATION ORGANISATION (CDMC)

2.197 NODAL DEPARTMENT RESPONSIBLE FOR VARIOUS ASPECTS OF THE CC :

The nodal department which bears the greatest share of the responsibility for formulating/controlling/monitoring directing measures for facing a cyclone disaster and for organising rescue/relief/rehabilitation (RRR) is according to administrative traditions the Revenue Department of the State Government.

2.198 DEPARTMENTS OF THE STATE/CENTRAL GOVERNMENTS AND VARIOUS AGENCIES/VOLUNTARY ORGANISATIONS IMPORTANT FOR CYCLONE DISTRESS MITIGATION WORK (CDMW) :

In the various aspects of the CDMW many departments of the State/Central Government are required to participate. A tentative list is given hereunder. Actual nomenclatures referring to the various departments change from state to state.

A. State Government : Departments of

1. Agriculture
2. Animal Husbandry
3. Civil Defence

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* Final report of the Cyclone Distress Mitigation Committee : Office of the Chief Engineer (Major Irrigation) Irrigation Branch, Hyderabad (1971).

4. Civil Supplies and Relief
5. Finance and Planning
6. Fisheries
7. Forest and Rural Development
8. General Administration
9. Home - Fire Services, Home Guards, Police Departments, etc.
10. Information and Broadcasting
11. Irrigation and Waterways - Flood Forecasting Organisations
12. Municipal Administration
13. Panchayat Raj
14. Power Production Department - State Electricity Board etc.
15. Public Health
16. Public Health Engineering
17. Refugee Relief and Rehabilitation
18. Revenue - Coastal Development Authority (CDA) proposed in paragraph 2.289 Section VI.B
19. Road Transport and Building - State Transport Corporation, Public Works Department.

B. Central Government :

1. All India Radio
2. Central Water Commision - Flood Forecasting Organisation
3. Central Power Commission
4. Coast Guard Department
5. Defence Establishment in the State - Army, Navy and Airforce
6. Indian Meteorological Department - ACWC/CWC
7. Port Authorities in the State
8. Posts & Telegraph Department
9. Railways Ministry
10. Shipping and Transport Ministry

Many voluntary organisations customarily participate in the RRR work :

C. Voluntary Organisations :

1. Indian Red Cross Society
2. Organisations like Ramkrishna Mission and Bharat Seva Sangha etc.
3. Other bodies like Lions and Rotary Clubs.

2.199 PRINCIPAL EXECUTIVE OFFICERS INVOLVED IN DIRECTING/ COORDINATING THE CDMW :

The Chief Secretary is in overall charge of the CDMW specially of all policy/strategy decisions regarding a cyclone disaster as he is for any other type of diasasters and is ultimately responsible to the Chief Minister of the State. The other senior executives are listed hereunder.

A. The State Government : It has been mentioned that traditionally the Department of Revenue is the department most concerned with natural calamities which are on the scale involving large populations. It has therefore become the custom that the Commissioner of Revenue of the State would be in overall charge of directing/coordinating all the CDMW work including the assessment of loss of life/ damage to property and organise all contingent ERRR work including reconstruction work. Maintenance of essential services would also come under his control during the period of cyclone emergency. To give him some relief some coastal states have appointed a Cyclone Rescue Relief and Rehabilitation Officer with the rank of ex-officio Secretary to the State Government to organise/control the RRR work. The Committee felt that this was a step in the right direction though it might not be necessary to appoint such an officer specifically for cyclone only unless he is given responsibilities in the general area of cummunity preparedness against cyclones during noncyclonic seasons. Since all coastal State Governments may not have appointed a Commissioner for Cyclone Relief and Rehabilitation, the Committee recommended :

CRC/110 : The coastal State Governments should each create a permanent cell under a Commissioner for Cyclone Rescue Relief and Rehabilitation (CCRRR) to supervise all Rescue/Relief/Rehabilitation (RRR) operations called for a cyclone emergency. The Commissioner may be given the rank of an ex-officio Secretary in the State Government. In noncyclonic season in the CPARs of the State the CCRRR cell in colaboration with the proposed Coastal Development Authority may organise construction of roads/bridges/Cyclone Shelters/Cyclone Stores, enforce building codes and undertake the necessary operations for public health maintenance and supervise public health engineering measures to keep the community prepared for cyclones.

The list of officers dedicated to CDMW during cyclone emergency are :

(b) Director-Agriculture

2. Department of Animal Husbandry

    (a) Secretary to the Department
    (b) Director of Animal Husbandry

3. Department of Civil Defence

4. Department of Civil Supplies

    (a) Commissioner of Civil Supplies
    (b) District Supply Officer

5. Department of Finance and Planning

    Finance Secretary

6. Department of Fisheries

    Director - Fisheries

7. Department of Forest & Rural Development

    Secretary to the Department

8. Department of General Administration

    Joint Secretary to the Department

9. Department of Home

    (a) Home Secretary
    (b) Director General - Police Department
    (c) Superintendant - Police
    (d) Director - Fire Services

10. Department of Information and Broadcasting

    (a) Director General - Information and Broadcasting
    (b) District Public Relation Officers

11. Department of Irrigation

    (a) Irrigation Secretary
    (b) Chief Engineer (Major Irrigation)
    (c) Director of the State Flood Forecasting Organisation

12. Department of Panchayat Raj

    (a) Secretary to the Department
    (b) Chief Engineer - Panchayat Raj
    (c) Block Development Officers

(d) Chairman - Zilla Parishads
(e) Village Munsifs

13. Department of Power Production

(a) Secretary to the State Electricity Board
(b) Divisional Engineers of the State Electricity Board

14. Department of Public Health

(a) Secretary to the Department
(b) District Medical and Health Officer
(c) Director, Medical and Health Service
(d) Superintendant, Government General Hospital

15. Department of Public Health Engineering

Secretary to the Department

16. Department of Revenue

(a) Secretary to the Department
(b) Commissioner of Cyclone Relief and Rehabilitation
(c) Commissioner of Land Revenue
(d) Chairman - Coastal Development Authority
(e) Division Collectors
(f) Divisional Revenue Officers
(g) District Collectors
(h) Tehsildars/Deputy Tahsildars/Hazur Sheristadars

17. Department of Roads and Transports

(a) Secretary to the Department
(b) Chief Engineer - Roads and Building
(c) Executive Engineer - Roads and Buildings
(d) Head of Public Works Department
(e) Director - State Transport

B. The Central Government

1. All India Radio

Station Directors of the AIR stations in the State

2. Central Water Commission (CWCM)

Deputy Director Flood Forecasting Organisations of CWCM

3. The Defence Establishments in the State
    - (a) Commander (Army) in the State Subarea
    - (b) Flag Commander Commander in Chief in the Coastal State Subarea
    - (c) Commander of the IAF headquarters in the state subarea

4. Indian Meteorological Department
    Director of the concerned ACWC/CWC

5. Senior Executive of the Port Authorities

6. Post & Telegraph Department
    - (a) General Manager - Telephones
    - (b) General Manager - Telecommunications

7. Department of Railways
    - (a) General Managers of Railways passing through the CPARs of the State
    - (b) Station Masters in the CPARs of the State

2.200 OFFICERS LIASING BETWEEN VARIOUS DEPARTMENTS IN THE STATE GOVERNMENT FOR CDMW* :

Since so many departments of the State Government are involved in CDMW, many State Governments appoint senior officers from each of the involved departments to liase with the Commissioner of Revenue and with the Commissioner for Cyclone Rescue Relief and Rehabilitation continuously in various matters arising at different times during a cyclone emergency. The liason officers have the responsibility to ensure that appropriate advisories/orders are transmitted to their field officers indicating their duties/ specific tasks/functions before/during/after the cyclone. The Committee considered such appointments absolutely necessary for CDMW and there made a specific recommendation in this matter.

CRC/111 : A senior officer from each of the departments of the State Government concerned with Evacuation/Rescue/Relief/Rehabilitation (ERRR) works related to a cyclone emergency should be appointed a liase with the CCRRR continuously in various matters arising at different times during the emergency. These liasing officers would relay appropriate advisories/orders from the senior officers of their respective departments to the field officers regarding the latter's duties/function/specific tasks at all stages of the disaster, before/during/after.

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* Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh, Hyderabad (1981)

2.201 THE STATE CYCLONE COMMITTEE (SCYC)* :

There is no doubt that with so many departments of the State/Central Governments and nongovernment agencies required to be involved in the CDMW during a cyclone emergency to achieve the best results in terms of reduction of loss of life/loss of property, it is necessary to establish a high power standing Committee to supervise all aspects of the CEAP during the emergency. The Committee recommended :

CRC/112 : Each Coastal State Government should set up its State Cyclone Committee (SCYC) which should be in the nature of a Standing Committee to implement/ organise all the cyclone distress mitigation measures (CDMMs) in the coastal areas encoded in its CEAP to limit the loss of life and property under onslaughts from cyclones and mitigate the distress brought about by them. The SCYC should be the Apex Body controlling all aspects of cyclone distress mitigation work (CDMW) in the State.

CRC/113 : The composition of the State Cyclone Committee (SCYC) should be appropriate for the State on the lines indicated hereunder.

Chairman : Chief Secretary

Member Secretary : Commissioner - Cyclone Rescue Relief and Rehabilitation (CCRRR)

Members :

A. State Government

1. Agriculture and Community Development :
   Secretary
   Director - Agriculture
2. Animal Husbandry Department :
   Secretary
   Director : Animal Husbandry
3. Civil Defence Department :
   Secretary
4. Civil Supplies Department :
   Secretary
   Commissioner : Civil Supplies
5. Finance & Planning Department :
   Secretary
6. Fisheries :
   Secretary
7. Forest and Rural Development Department :
   Secretary
8. General Administration Department :
   Joint Secretary

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* Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh, Hyderabad (1981)

9. Home Department :
   Secretary
10. Director : Home Guards
11. Irrigation and Waterways Department :
    Secretary
    Chief Engineer - Major Irrigation
12. Panchayat Raj Department :
    Secretary
    Chief Engineer : Panchayat Raj
13. Police Department :
    Secretary
    Director General : Police
14. Power Generation Department :
    Secretary
    Chief Engineer : State Electricity Board
15. Public Health Department :
    Secretary
    Director - Medical and Public Health Services
16. Public Health Engineering Department :
    Secretary
    Chief Engineer - Public Health
17. Revenue Department :
    Secretary
    Commissioner : Land Revenue
    Chief Collector - Revenue
18. Chairman : Coastal Development Authority
19. Roads, Transport and Buildings Department :
    Secretary
    Chief Engineer - Public Works Department
    Chief Engineer - Roads
20. Refugee Relief and Rehabilitation Department :
    Secretary
    Commissioner - Relief

B. Central Government

1. The Central Water Commission : Director of Flood Forecasting Organisation in the State
2. Coast Guards : Director
3. Defence Establishments in the State
   (a) Army Commander in the State Subsector
   (b) Navy Commander in the State Subsector
   (c) IAF Commander in the State Subsector
4. Indian Meteorological Department : Director of the concerned ACWC/CWC except during a cyclone emergency
5. Indian Posts & Telegraph Department :
   (a) Director General - All India Radio (in the State Capital)
   (b) General Manager - Telecommunication (in the State Capital)
   (c) General Manager - Telephone (in the State Capital)
6. Railways : General Managers of the Railways passing through the CPARs of the State

7. Shipping and Transport Ministry :
   Chief Officer of the Port Authority in the State

C. Legislature

1. One member from the Lok Sabha from the State
2. One member from the Bidhan Sabha

D. Voluntary Relief Organisation

1. Chairman of the Branch of the India Red Cross Society in the State
2. Representatives from other voluntary relief organisation active in the State

2.202 TERMS OF REFERENCE OF THE SCYCs :

The terms of reference of the State Cyclone Committee were also discussed by the Committee. It recommended :

CRC/114 : The terms of reference of the SCYC should contain inter alia the following powers and responsibilities.

1. To set up Standing District Cyclone Committee (DCCs) for taking emergency executive measures during cyclone regimes.

2. To establish and maintain snap proof TC channels of communication with the DCCs for despatching advisories for precautionaries, instructions/orders for ERR and for receiving back reports on the actions taken.

3. To formally declare areas of the coastal regions as areas of Great Danger (area of likely landfall), Danger and under Alert : AGD, AD, AA.

4. To define and allot specific tasks to various departments of the State/Central Government and various agencies/voluntary organisation for the CDMW at various stages of the cyclone emergency and monitor on the progress of their efforts.

5. To mobilise the resources in men, materials and equipments of the State/Central Government and various agencies/voluntary organisations or that available from the public for the CDMW.

6. To advise the State Government about compulsive evacuation from identified AsGD during a cyclone.

7. To review periodically the Cyclone Emergency Action Plan (CEAP) for the concerned State in the light of experience gained with the objective to remove the lacunae if any.

2.203 CONTROL ROOM IN THE GENERAL ADMINISTRATION DEPARTMENT (CRGA) :

Generally the General Administration Department of all State Governments have a Central Room that functions round the clock all round the year. It would be natural to expect that as soon as the disaster situation actually develops, the CRGA would be manned with a team of officers from the Departments of Revenue, Police and Defence and serve as the principal monitoring centre for watching over the situation. All informations for the State Government would be received here or dissemination to proper addresses. All advisories/instructions/orders of the State Government to its various departments involved in the disaster and requests to departments of the Central Government/other agencies/voluntary organisations working on the CDMW would pass through the CRGA. The Committee recommended :

CRC/115 : As soon as a cyclone emergency develops, the Control Room-General Administration (CRGA) should be placed under the control of the CCRRR and manned by officers of the Departments of Revenue, Police and Defence and representatives from the IMD if available during the emergency. The CRGA should be connected by reliable TCCs to the departments involved in the Cyclone Distress Mitigation Work (CDMW) and with their field stations in the cyclone affected areas. The CRGA should function as a monitor centre watching over the disaster and also as a command post for relaying the advisories/instructions/orders/requests of the authorities to the various officers engaged in the CDMW. Large scale maps and all relevant informations like addresses of various officers/field units operating at the State Capital/District Headquarters/Field positions in the cyclone affected areas etc. should be available at the CRGA. The CRGA must in all circumstances keep unbroken telecommunication contacts with the concerned ACWC/CWC and the Flood Forecasting Organisation in the State.

2.204 MONITORING ROOM AT THE IRRIGATION DEPARTMENT (MRID)* :

It is generally the task of the Irrigation Department of a State to keep a close watch on the flood situation in the State. Since floods caused by heavy precipitation of rain water and storm surges are usually the factors which cause the greatest danger of life and property in a cyclone, the Committee recommended :

CRC/116 : As soon as a cyclone threat develops, the Chief Engineer (Major Irrigation) should set up a monitoring room in the Irrigation Department (MRID) at the State Headquarters to keep a close watch on the rainfall and the flood situation that may develop consequent to the cyclone. The MRID should be in unbroken telecommunication contacts with the CRGA, the Flood Forecasting Organisations in the State and the concerned ACWC/CWC.

2.205 DISTRICT CYCLONE COMMITTEES (DCCs) :

The executive actions must be taken by the officials posted in the affected districts. It is necessary to evolve a mechanism to bring them together in an emergency so that they can work out a strategy to meet the threat.

CRC/117 : District Cyclone Committee (DCCs) may be set up at the Headquarters of the districts in the CPARs.

CRC/118 : The composition of the DCCs may be as follows :

Chairman : District Collector

Member : One member may be nominated from each of the following bodies

A. State Government

1. Agriculture Department
2. Animal Husbandry Department
3. Civil Defence Department
4. Civil Supply Department : District Supply Officer
5. Fisheries Department
6. Forestry and Rural Development Department
7. Information and Broadcasting Department : District Public Relation Officer
8. Police Department : District Police Superintendent
9. Public Health Department : (1) District Medical and Health Officer, (2) Superintendent, Government General Hospital
10. Public Health Engineering Department : District Engineer
11. Public Works Department
12. Refugee Relief Rehabilitation Department
13. State Electricity Board : District Engineer
14. State Transport Department

B. Central Government

1. The IMD representative if available in the District
2. Coast Guards Department
3. Defence Establishment in the District Headquarters - Army, Navy and Airforce : from units stationed in the District
4. Post and Telegraph Department

C. Legislature

One member from the State Bidhan Sabha from the District

D. Voluntary Organisation

1. Indian Red Cross Society
2. Representatives of other voluntary relief and Rehabilitation organisation active in the district

The office of the District Collector will do the Secretariate work and send out the executive orders of the DCC for the Cyclone Distress Mitigation Work (CDMW) via the Cyclone Control Room (CCR).

2.206 TERMS OF REFERENCE OF THE DCC :

The Committee also recommended :

CRC/119 : The terms of reference of the DCCs should inter alia be

1. To inform the public by organising beating of drums, or sirens or by flares (during night time) or by any other means about the threat of the cyclone.

2. To maintain a Cyclone Control Room (CCR) in the office of the District Collector to organise and correlate all executive actions by him. The CCR would issue to the public and special warnees instructions about precautionary measures to be taken and instructions/orders for evacuation/relief/rehabilitation to the cyclone victims.

3. To mobilise the local resources in manpower and materials like vehicles, powered launches for evacuation/rescue, drinking water, relief as food/clothes/blankets and medicines to combat epidemics of dysentery and cholera etc., and maintain adequate stocks of these materials.

4. To utilise all the resources available locally or through the State Government via the SCYC or from other agencies and organisations and send them for this purpose to wherever they are necessary.

5. To organise evacuation and rescue operations in the Areas of Great Danger (AsGD).

6. To set up and run refugee camps till the affected people can be satisfactorily rehabilitated.

7. To organise protection from antisocial criminal elements of property in the AsGD from where people have been evacuated.

8. To make immediate assessment of cyclone caused damages in the district and report to the Secretary of the Revenue Department.

2.207 MEETINGS OF THE DCCs :

The Committee discussed how frequently the DCC should meet in the year. It recommended :

CRC/120 : The DCCs should meet at least twice a year in April and August just at the start of the premonsoon and postmonsoon cyclone seasons. At these meetings actions taken for preparing the community for cyclones and the success of the CEAP in fighting the cyclones of the immediately preceeding period may be reviewed.

The recommendation about emergency meetings of the DCCs is given in paragraph 2.223.

2.208 CYCLONE CONTROL ROOMS (CCRs) :

The composition and executive responsibilities of the Cyclone Control Room in the District Headquarters were also discussed. The Committee recommended :

CRC/121 : During a cyclone emergency a DCC in a cyclone affected region should set up a Cyclone Control Room (CCR) which will be in the nature of a monitoring/command post during the emergency. The organisation and the executive responsibilities of the Cyclone Control Rooms at the District Headquarters should be as follows :

Organisation :

Officer in charge of the Cyclone Control : PA to the District Collector or any other officer nominated by him

Representatives from various organisations to be stationed at the CCR during a cyclone regime :

1. Police Department
2. P&T Department
3. Public Health Department
4. Public Health Engineering Department
5. Revenue Department : Tehsildars, Hazur Seristadars

Responsibilities :

1. To receive from the SCYC on behalf of the concerned DCC the orders/instructions for dissemination of CAs and Evacuation/Rescue orders/instructions and advisories about Relief/Rehabilitation measures for the victims in the cyclone affected regions, fishing boats at sea, and transports on road.

2. To transmit instructions/orders of its DCC regarding the CAs, and the evacuation/rescue/relief/rehabilitation advisories to various groups of people or organisations in the cyclone affected regions.

3. To monitor continuously during a cyclone the broadcasts of the CBs by AIR and pass on the informations to its DCC.

4. To establish direct communication with the concerned ACWC/CWC : for obtaining the latest information about the cyclones and pass on the information to its DCC.

5. To establish communications with the Police Headquarters for conveying requests from its DCC for evacuation/rescue of cyclone victims from the AsGD.

6. To establish contact with local Defence authorities for any special assistance required by its DCC.

2.209 ACTIVATION/DEACTIVATION OF THE CCRs :

The District Collector should be the official given the power to decide when to activate the CCR and when to deactivate it. The Committee recommended :

CRC/122 : The District Collector should be given the power to activate the CCR after the first stage 'Cyclone Alert' warning is received by him. Normally the CCR should be deactivated after the cyclone has collapsed and the 'Cyclone

Dewarning' signal is received by him. But he should have the discretion to keep the CCR activated in the interest of rescue/ relief/rehabilitation of the cyclone victims.

2.210 WORK ROUND THE CLOCK AT THE CCRs DURING CYCLONE EMERGENCIES :

It may be necessary for the CCR to work round the clock during a cyclone regime. The Committee recommended :

CRC/123 : During cyclone regimes after the 'Cyclone Alert' signal has been upgraded to 'Cyclone Warning' level, the CCRs should work round the clock and the consequent administrative problems should be resolved by the State Government.

2.2111 CDMO AT THE CITY/TALUK/VILLAGE LEVELS :

At the taluk level it would be convenient to have taluk Cyclone Committee (TCYCs). The Committee recommended :

CRC/124 : At the taluk level standby Taluk Cyclone Committee (TCYCs) may be constituted with members nominated by the District Collector. These would be responsible for carrying out instructions issued by the CCRs of the DCCs.

At the city, taluk and village levels organisations are necessary to supervise the execution of the CAs and various other tasks aregarding evacuation/rescue. The Committee did not feel that seperate organisations at this level are necessary specifically dedicated to cyclones. It recommended :

CRC/125 : At the village level, the Gram Panchayats would be sufficient to supervise the execution of the CAs/ instructions/orders issued via the concerned TCYCs from the CCRs of the concerned DCCs. During cyclone regimes representatives of the P&T department and the local Police should be associated with the Gram Panchayats to help these bodies.

CRC/126 : At the city level the Municipal Authorities should organise, if necessary, emergency cells to meet the threats of an impending cyclone. For the execution of the CAs/ instructions/orders of the concerned DCC through their CCRs. These bodies should call upon other organisations for help if necessary.

2.212 ROLE OF THE DEFENCE FORCES IN CDMW :

At various stages that it may become necessary to request help in active terms from other organisations - particularly from the Defence Department who have built up a tradition of rescue and relief work during national disasters. This matter was discussed in the meeting of the CS also. The policy of the Ministry of Defence in the matter of aid to civil authorities is that the civil authorities should merely indicate the tasks and the Defence authorities would mobilise their resources to fulfil the tasks. Furthermore in the matter of equipments that would be necessary by the Defence authorities to help in cyclone fighting, it is necessary that these should be idenified by joint consultation with the Defence authorities at the SCYC level. It would be also a matter for decision whether the Defence forces could be equipped with special equipments which could be of regular use to the Defence. and could also be used in cyclone emergencies. The extra expenses for procuring such equipments could be paid by the concerned State Government, but the responsibility of monitoring them should rest with the Defence department. The Committee recommended :

CRC/127 : The SCYC should have joint discussions with the representatives of Ministry of Defence for identifying the equipments which the Defence forces would need to help in a cyclone emergency and also the scale at which they should be distributed to the various administrative echelons within the State Government. Some equipments, which are required for cyclone emergency but can also be put to regular use for their own need by the Defence forces, could be purchased by the State Government and maintained by the Defence forces.

CRC/128 : The DCC should have joint discussions with the representatives of the Defence Forces in the district after the cyclone warning has been upgraded, regarding the time and modality of seeking assistance from them. It is necessary that during these meetings, the specific tasks that the Defence Services would be required to undertake in a cyclone emergency, be clearly defined to them.

V.C TCCs FOR CDMW

2.213 TCCs NEEDED AT THE SCYCs, DCCs, CCRs AND TCYCs :

The Committee discussed the question of communication with the CRGA which would be the communication hub of SCYC in a cyclone emergency, the State Cyclone Committee, the ACWC/CWC, the CCRs which are the communication centres of the DCCs and the TCYCs and the city and village committees. By and large the CRGA would use the normal TC channels which are already installed at the State Secretariate for communication with the CCRs. These are the traditional land based Telegrams, Telex and TP channels. It is therefore necessary that the CCRs have these facilities as well as transistor receivers to monitor the CBs broadcast by the concerned ACWC/CWC and the AIR stations in the State. The Committee recommended :

CRC/129 : The CCRs should be equipped with Telephone Telex and TP/WT channels and also with transistor radios to monitor the CBs broadcast by the concerned ACWC/CWC and the AIR stations in the State. Messangers on cycles and other vehicles should be put at the disposal of the CCRs.

2.214 USE OF POLICE WT CHANNELS BY THE CCRs :

The State Police maintains a communication system all over the State based on the WT mode. This could provide a very reliable communication link between the CCR and selected strategic points where the cyclone advisories must reach during a cyclone regime. The Committee has already recommended this (Recommendation CRC/92).

2.215 SPECIAL TCC AT THE TALUK/CITY/VILLAGE LEVELS IN AREAS OF GREAT DANGER (AsGD) :

At the taluk/city/village levels the T.C. channels must necessarily be the land based telegrams and in the zones of Great Danger the mobile WT station which have to be installed there during a Cyclone regime. The Committee recommended :

CRC/130 : On request from the concerned DCC mobile WT stations may be installed by the Police at strategic points in the declared Areas of Great Danger in the local Post Offices where telegram receiving and sending facilities are available.

2.216 NORMAL TCCs/WARNING EQUIPMENTS AT THE TALUK/CITY/ VILLAGE LEVELS :

It is to be expected that all the normal land based TCCs would exist at the taluk/city/village levels. Thus the local post offices would naturally take up the role of communication hub in the event of cyclone emergencies. Since however often much time is wasted when trying to send messages through these channels which moreover are not immune to cyclones, the Committee recommended :

CRC/131 : It is advisable to appoint a temporary cadre of messengers/peons at the cyclone centres at the taluk/city/village levels who can take messages/instructions/orders to various places on cycles/motor cycles/other means.

It is very important that there be stores of warning equipments at the taluk/city/village levels because the warnings at these places are most urgently needed to save life and property. The Committee recommended :

CRC/132 : Each Cyclone Distress Mitigation Centre (CDMCN) at the taluk/city/village level should always have adequate stock of warning equipments : drums, tomtoms, mobile vans with loudspeakers. At various strategic places particularly in the cities sirens should be installed and these should be properly maintained so that they can be used when needed.

V.D VARIOUS PHASES OF CDMW

2.217 SEQUENCE OF PHASES OF CDMW :

There are three distinct phases of the CDMW and the CC must lay down specific action plans for each phase. The actions plans in the various phases would cover the following aspects :

1. Cyclone Alert phase : First phase
    - (a) Activation of the CDMO
    - (b) Issuance of warnings
    - (c) Precautionary/Preventive/Preparative measures
2. Cyclone phase : Second Phase
    - (a) Actions of the various Cyclone Committees
    - (b) Issuance of CAs to areas of Danger/Great Danger
    - (c) Specific actions to be taken by various departments of the State/Central Government, various agencies and voluntary organisations
    - (d) Specific actions to be taken for evacuation/rescue
    - (e) Specific actions taken with regard to relief camps
    - (f) Maintenance of essential services
    - (g) Distribution of relief to cyclone victims
3. Post Cyclone phase : Third phase
    - (a) Restoration of coastal services
    - (b) Disposal of bodies of human/cattle killed by cyclone and removal of debris caused by it
    - (c) Prevention of epidemic

(d) Rehabilitation of cyclone victims
(e) Assessment of loss of life/property
(f) Reconstruction

The various phases will be discussed separatly

V.D(1) MEASURES TO BE TAKEN ON RECEIPT OF 'CYCLONE ALERT' SIGNAL FROM THE CONCERNED ACWC/CWC - THE FIRST PHASE

2.218 ACTIONS BY THE ACWC/CWC AND FFOs IN THE STATE :

Apart from issuing the 'Cyclone Alert' signal the concerned ACWC/CWC should take the following responsibility. By the time the Cyclone Alert signal the cyclone is close to the coast and the concerned ACWC/CWC should have a fair idea of whether and where it may landfall. It should therefore be able to estimate the areas of Great Danger, Danger and Alert. It should prepare a preliminary cyclone risk map showing the hazards in the various areas and send it to the SCYC along with warning signal. The Committee recommended :

CRC/133 : The coastal State Governments should prepare large scale suitable Cyclone Hazard Potential Map (CHPM) areawise based on contour maps referred to under CRC/7 and past experience gathered from specific area regarding devastations caused by storms and flood vulnerability and on risk analysis derived from these data. The maps should be made available to the SCYCs and all the DCCs of the coastal States.

The flood Forecasting Organisations in the State on receipt of 'Cyclone Alert' signal should begin studying the flood risks to be faced by the State.

2.219 EMERGENCY MEETING OF THE SCYC ON RECEIPT OF THE 'CYCLONE ALERT' SIGNAL :

The Committee recommended :

CRC/134 : As soon as the 'Cyclone Alert' signal is received by the Chief Secretary, a meeting of the SCYC may be called by the Commissioner of Cyclone Rescue Relief and Rehabilitation (CCRRR) to discuss inter alia the following items :

1. Monitoring the CWMs broadcast by AIR and by the CRGA round the clock till 'Cyclone Dewarning' signal is issued by the concerned ACWC/CWC

2. Alerting the concerned DCCs about the impending cyclone

3. Taking decisions on plans and strategies to meet the approaching cyclone

4. The allotment of tasks and responsibilities to various departments of the State Government
5. The issuance of requests for help to other agencies and departments of the Central Government like AIR, Defence, P&T Department, etc.
6. To arrange transmission of CA part of the CBs to the various groups of warnees and designated State Government Officials assigned to CDMW over the co communication channels of the State Government.
7. The creation of a cell responsible for drafting and issuance of the CAs
8. Mobilisation of vehicles, road and water transports like trucks and buses of the State Transport Department, lorries, powered launches, country boats for possible evacuation/rescue operations
9. Stocking reserve of various relief material - food grains, clothing, medicines for possible distribution amongst cyclone victims and medicines to stop epidemics that may follow in the wake of the cyclone
10. Establishment of contact with the Flood Forecasting Centres in the State of the CWCM/State Irrigation Department/IMD and the concerned ACWC/CWC of the State for issuance of storm surge/flood advisories. The actual storm surge warnings will be issued by the ACWC/CWC to the SCYC after consultation with the Flood Forecasting Centres.
11. Maintenance by the P&T Department of reliable snap proof TC channels with the ACWC/CWC and the DCCs of the affected areas (via their CCRs)

2.220 ALERTING OF THE UNITS OF THE CDMO IN THE THREATENED DISTRICTS ON RECEIPT OF THE 'CYCLONE ALERT' SIGNAL :

On receipt of the 'Cyclone Alert' signal the Commissioner of Cyclone Rescue Relief and Rehabilitation should alert the various components of the CDMO about the impending cyclones. The Committee recommended :

CRC/135 : On receipt of the 'Cyclone Alert' signal the Commissioner Cyclone Relief and Rehabilitation should alert

1. The Irrigation Department
2. The Revenue Department
3. The District Collectors in the threatened areas

The conerned District Collector should in turn warn the Municipal authorities, Panchayat Pradhans, Police establishments, Tahasildars in the threatened areas. The Tahasildars should warn the local officers/village committees and start arrangments for activating the public warning system.

2.221 ALERT IN THE REVENUE/IRRIGATION DEPARTMENTS :

As soon as the Revenue and Irrigation Departments have been alerted, the Revenue Department should mobilise all the officers in the threatened district. The Committee recommended :

CRC/136 : The District Officers who are away on tour should be immediately recalled to District Headquarters to meet the District Collector. It must be seen that no officer is on tour or on leave during the period of the cyclones.

The Committee also recommended :

CRC/137 : The monitoring room of the Irrigation Department (MRID) should be activated to watch over the development of the flood situation in the threatened districts. Inspection at close intervals of the State of the water levels in the hydrodams, water reservoirs, rivers etc. in the areas marked out in the Cyclones Hazard Potential Maps, should commence at this stage.

CRC/138 : On receipt of the 'Cyclone Alert' signal from the ACWC/CWC or from the Commissioner - Cyclone Rescue Relief and Rehabilitation of the State Government, the first emergency meeting of the DCCs in the threatened districts should be called by the respective District Collector to work out in advance the strategies to be employed. The DCC in any affected district should be more or less in continuous session when the Warning signal is upgraded there to the second stage 'Cyclone Warning' signal.

2.222 CYCLONE ADVISORIES FROM THE CRGA FOR COASTAL WATER TRAFFIC VIA AIR BROADCASTS :

Though the period of Alert is one of waiting for the people living on the coast because the cyclone is still out on the sea, it is a period of very great danger to fishermen in the field of the cyclone. The Committee also recommended :

CRC/139 : Though the period of 'Cyclone Alert' is the period of little actual danger for people residing on land, it may be the period of the highest danger for fishermen on sea particularly for those who are directly in the path of the cyclone. The CAs should therefore contain detailed advisories for sailing, homing and sheltering to nearest identified ports, storing of boats and fishing equipments. The SCYC should directly issue these advisories through AIR broadcasts which should be monitored by the fishermen for taking appropriate safety measures.

2.223 MEETINGS OF THE DCCs ON RECEIPT OF 'CYCLONE ALERT' SIGNAL :

The Committee recommended :

CRC/140 : The following items should be on the agenda for discussion/action in the first emergency meeting of the DCCs.

1. Activate their respective CCRs
2. Establish immediate contacts with
   - (a) the Police Headquarters and the Thanas in the locality which are threatened by the cyclone, and alert them to standby for establishment of communication with the CCRs
   - (b) the P&T Department requesting them to bring up their communication system upto the taluk, block and village levels to a full state of efficiency
   - (c) the Defence authorities in the districts and alert them to standby for help the State authorities in possible evacuation/rescue operations
   - (d) with the nearest AIR station directly
   - (e) the local fire fighting units, coast guards, civil defence units, Irrigation officials, PWD officials, Public Health officials, Public Health Engineering officials asking them to be on the alert
   - (f) the voluntary rescue/relief organisations that generally operate in the State asking to be on the alert.

If there are any lacunae in the communication systems with these bodies then to take immediate steps to remove them or provide alternative.

3. To study the Cyclone Hazard Potential Map supplied by the State Government obtained from the SCYC/ Revenue Department/Irrigation Department and review of the approach ways to the possible areas of Danger/ Great Danger for possible subsequent evacuation and rescue.

4. Identification from the list of shelters : Temples, Mosques, Churches, Municipal High Schools, high grounds, special Cyclone Shelters (CYSHELs), previously selected by the DCC, for mention in the CAs as the recommended gathering points for the refugees and evacuees if the cyclone warning is later upgraded.

5. Identification of Health Centres and assignment of medical workers and provisions of drugs/medicines/ vaccines at strategic points in the district for fighting epidemics, that follow in the wake of the cyclone, and planning of removal of affected persons from the scenes of disaster to these centres, and generally providing first aids for minor injuries to men and cattle.

6. Arrangements of messengers and despatch riders on cycles, motor, jeeps, motor bikes, horsebacks for communication with the officials of the TCYCs, City Municipalities and Panchayat Offices at the villages to alert them of the impending cyclone.

7. Review the state of the Cyclone Shelters and bring them up to the level of preparedness to receive cyclone victims.

8. Review the state of the equipments at the Cyclone Stores for evacuation/rescue, debris removal, medicines for first aids/equipments etc. and send requisitions to the appropriate department of the State Government - Public Works Department, Public Works Engineering Department etc. and Agro Industries Complexes etc.

9. Review the stock of the food grains, dry food commodities, clothing materials and fuels like kerosene and diesel oil etc. that may be available for the cyclone victims and send the requisition for any deficit in this respect to the Department of Supplies of the State Government.

10. Assessment of vehicles - lorries, powered launches, country boats needed for warning/evacuation/rescue

for a requisition to be sent to the SCYC and mobilisation of what is available locally and despatching the equipments and vehicles received or commandeered to wherever they are needed. Adequate stock of petrol/diesel oil should be assured for these vehicles and stocked at suitable strategic distribution centres.

11. Detailing all personnel for CDMW to their respective stations.

12. Requesting the PWD to inspect all roads, tanks, bunds, bridges, buildings marked for sheltering evacuees and refugees and to take steps to strengthen and repair them.

13. Requesting the PWD to remove also the dead and dying trees from the road side to prevent them from falling on people during the cyclone regime

14. Issuance of CAs to local CDMO units at the taluk/city/village levels for warning and bringing them to the public by whatever means that is available to them.

15. Analyse the preliminary flood risk map received from the Irrigation Department/Flood Forecasting Organisations in the State to take decisions on the necessary steps.

16. Set up a large scale map of the threatened areas in the office of the District Collector for reference/guidance.

CRC/141 : From the time the first meeting is held, all communications sent/received from the SCYC, Departments of the State/Central Government, various Agencies/Voluntary Organisations, ACWC/CWC, Flood Forecasting Organisations should be preserved by the DCCs for record.

CRC/142 : The respective CCR should constantly monitor the CWM broadcasts of AIR after the 'Cyclone Alert' signal is received by the DCC.

2.224 LOCAL CYCLONE WARNINGS :

As soon as the Cyclone Alert signal reaches the Taluk/City/Village Cyclone Units, the people in the threatened localities should be warned by whatever means that is available. The Committee recommended :

CRC/143 : On receiving the 'Cyclone Alert' signals the officials in the local CDMO units at the Taluk/City/Village level should take immediate measures to warn the people in the threatened areas of the impending cyclone by whatever means that is available - by beating drums/tomtoms, coloured tethered orange coloured balloons/pennants visible from long distances, mobile vans carrying public address systems, sirens etc.

2.225 ACTIONS TO BE TAKEN BY THE DIFFERENT DEPARTMENTS OF THE STATE/CENTRAL GOVERNMENTS, AGENCIES AND VOLUNTARY ORGANISATIONS ON RECEIPT OF THE 'CYCLONE ALERT' SIGNAL :

The Committee considered the various urgent actions that must be taken at the Cyclone Alert stage by the various units of the CDMO. It recommended :

CRC/144 : There are a number of urgent actions that must be taken at the Cyclone Alert stage by the various departments of the State/Central Governments, agencies and voluntary organisations. Some of these steps are listed hereunder :

A. State Government :

1. Agriculture Department : The Director of Agriculture should issue advisories to the farmers in the threatened areas to take precautionary measures to save the crops in the fields and store cut crops and agriculture products on raised platforms or covered sheds.

2. The local CDMO units at the taluk/city/village levels in the threatened areas : These should be in a state of alert and preparedness. In particular they should take prompt actions on the reports of the Municipal authorities/Major Panchayats.

3. Fisheries Department :

   (a) The Director - Fisheries will immediately arrange to issue advisories to the fishermen on the threatened coastal regions not to put out to sea and secure their boats/nets in safe storage places to avoid damage,

   (b) The fishermen living at particularly low lying places should be moved to safer places,

   (c) Arrangements should be rade to give first aid/medical attention to injured fishermen **who** return .

4. Irrigation Department :

   (a) Flood monitoring room (FMR) should be immediately established in the office of the Superintendent Engineer's office to keep a watch on the local flood situation and feed the information to the MRID at the office of the Chief Engineer (Major Irrigation)

   (b) The head regulators of the Irrigation system serving threatened coastal areas should be closed and the water allowed to pass through the river course.

5. The Municipal authorities/Major Panchayats :

   (a) They should review the stock of food/clothes from which supplies can be drawn when the actual emergency occurs,

   (b) The Municipal authorities/Major Panchayats equipped with public water supply facilities should ensure that the maximum quantity of water is stored in overhead tanks/water towers. The water tankers with the Municipalities should be brought up to a state of usuability and filled up with water.

   (c) These authorities should instal emergency diesel sets for generation of electric powers for installations needed for maintenance of essential services - pumps for lifting drinking water and removal of flood water, lighting at important units of the CDMO,

   (d) The Panchayat authorities should inspect the Cyclone Shelters (CYSHELs) and bring them up into a stage when they can be used. They should inspect the approach roads of the CYSHELs and report to their local unit of CDMO,

   (e) They should inspect the local health centres/hospitals and the stock of drugs/medicines/vaccines against epidemics and report to the local unit of the CDMO,

   (f) They inspect the stock of various materials/equipments - boats/vehicles/floats/ladders/hooks etc. at the cyclone stores (CYSTORs) and report to the local unit of CDMO,

   (g) These authorities should inspect all possible sources of hazards - dying/rotten trees, unsafe building structures etc. and report of the local unit of the CDMO,

(h) These authorities should inspect the state of the roads and bridges in their areas and report to the local unit of the CDMO,

(i) They should inspect the state of water drainage and sewerage in their locality and remove any blocking/choking of the pipes/channels so that they are in a good enough state to carry away flood water. If possible, pump sets should be set up at important points during the emergency for pumping out the water.

6. The Police Department :

(a) In most states the Police units are equipped with VHF W/T sets(paragraph 2.124). Mobile sets should be set up, if not installed already, at strategic points for transmitting informations relating to floods and cyclones. As has been stated already this is outside the normal scope of work of the Police Department, but may be permitted during disaster emergencies (paragraph 2.168, CRC/92). There should be standing orders that the officers of the Revenue Department and various units of the CDMO to use the WT/VHF sets during cyclone emergencies,

(b) During cyclone emergencies mobile vans stationed at important Police Stations should be equipped with VHF sets.

(c) When commandeering jeeps/vehicles, it is also necessary to draft Police drivers and kept on duty for driving the vehicles in case the drivers in the employment of Shate Government are not found,

(d) The Police Department should insist on the prohibition of passage of all vehicles, as far as necessary, on the roads in the threatened areas to avoid the passengers from being stranded.

7. The Power Department :

(a) The State Electricity Board/various Electric Supply Companies in the threatened areas should make arrangements to disconnect power in the threatened areas. Arrangements should be made to instal generators at important Municipal towns for only very essential purposes. A list should be maintained by the department of the locations from where generators can be commandeered - cinemas/theatre halls etc.

(b) The Executive Engineer - Power Department in the threatened area should keep himself informed by his counterparts from other districts about the power produced and available for his area and when it is possible to draw this power.

8. The Public Health/Public Health Engineering Department:

(a) The Superintendent, Government General Hospital and the District Medical and Health Officer should keep teams of doctors ready with stocks of medicines/vaccines necessary for relief/ prevention of epidemics. The District Medical and Health Officer should prepare a list of Government/Private medical doctors who can be called upon to serve during an emergency created by a cyclone,

(b) The state of medical stores at the CYSHELs/ Cyclone stores/other stores should be inspected by the District Medical and Health Officer and deficit of stock made up for the emergency. He should see that adequate stocks of drugs/ medicines/vaccines/vitamins/chemicals for giving medical relief to cyclone victims and to control epidemics is available,

(c) The District Medical and Health Officer should see that adequate number of ambulances are available for relief work and that they are positioned at strategic points from where they can move to the affected areas quickly without loss of time. If sufficient numbers are not available, vehicles should be commandeered and put into use as ambulances. Drivers/ maintenance technicians for the vehicles/ ambulance attendants/paramedical men should be found for these emergency ambulance fleet.

9. The Public Works Department :

(a) The PWD should inspect the weak bunds of all irrigation sources near and around the villages and keep watch over the weak points for taking timely action against any possible breaches.

(b) The PWD should inspect the head gates of the irrigation channels and take necessary repair measures if needed. The Department should inspect the water drainage system and take necessary remedial measures.

(c) The PWD should inspect all public buildings in the threatened areas and take reinforcement/demolition measures as necessary.

10. The State Transport Department :

(a) The State Transport buses, private buses and lorries, jeeps, tempoes should be requisitioned, put under the control of this Department and moved to strategic points near the threatened areas,

(b) Sufficient stock of petrol/diesel should be collected at convenient distribution points,

(c) Drivers and other support staff should be called in for duty during the emergency for driving the vehicles to the threatened areas for evacuation/rescue work.

(d) When commandeering jeeps/vehicles, it is also necessary to draft Armed Reserved Police drivers and kept on duty for driving them in case the drivers in the employment of State Government are not found.

11. Department of Supplies :

(a) The District Supplies Officer should make arrangements for withdrawal of food grains like rice, wheat etc. from the godowns of the Food Corporation of India, State Civil Supplies Corporation and similar organisations,

(b) The Department should maintain a stock of durable eating materials : bread, buns , puffed/pressed rice,,chhattu etc.

(c) The District Supplies Officer should obtain sufficient stock of petrol, kerosene, diesel in local distribution centres on Government account and keep them ready for use.

B. Central Government :

1. The Defence Establishment in the State :

(a) On being alerted by the DCC the Defence authorities should keep ready of vehicles/amphibians/powered boats that may be need for evacuation/rescue operations,

(b) All equipments that may be necessary of evacuation/rescue operations in the second phase of CDMO should be kept ready and available for use,

(c) The Defence authorities should keep a number of Helicopters for aerial survey/food dropping/ rescue of sick persons in cyclone infested areas if requested,

(d) The Communication channels of the Defence establishment in the State should be held ready for CDMW if requested.

2. Port Authorities :

(a) Arrangements should be made for safe berthing of ships in the ports. If necessary the ships may be directed to move out to the open sea where they may be safer,

(b) The Port Trust Authorities should be given the responsibility of evacuation/rescue work when water transports : powered launches/boats/ country boats are needed. All such transports after collection by requisition/commandeering should be put under the disposal of the Port Trust Authorities. Sufficient stocks of petrol/ kerosene should be reserved for this purpose.

3. The Post & Telegraph Department :

(a) The Department should inspect its land based TC systems that will be used for dissemination of Cyclone Advisories/Bulletins/Informations and bring it up to a level that it can perform these tasks. If possible alternative communication channels in the form of VHF/UIHF/ microwave links should be provided,

(b) The Department should provide men and materials/ equipments at all units of the CDMW for restoring/repairing the communication system as and when needed,

(c) The Department should keep in order the telephones of all officials connected with CDMW.

4. Railways :

(a) All the trains on tracks passing through the threatened areas should be brought to a halt at the nearest railway station,

(b) All personnel on duty at the stations located with threatened areas should be warned to standby,

(c) Arrangements for food/medical attention should be made at all the stations for the period of the cyclone,

(d) The Railway Microwave system should be available to the District Collector during a cyclone emergency if necessary.

V.D(2) CODE OF ACTIONS TO BE TAKEN ON RECEIPT OF 'CYCLONE WARNING' SIGNAL - THE SECOND PHASE :

2.226 FEATURES OF PHASE 2 OF THE CDMW AFTER THE 'CYCLONE WARNING' SIGNAL IS ISSUED :

When the 'Cyclone Alert' signal is upgraded to 'Cyclone Warning' signal it can be assumed that the concerned ACWC/CWC has a fairly accurate idea of the locations of the landfall point and the parameters of the cyclone. The concerned ACWC/CWC has also an assessment of the possible intensity/extent of the accompanying storm surge and the Flood Forecasting Organisations in the State (FFOs) have gathered full information on the possible precipitation of rain and the state of water distribution on land. The ACWC/CWC should be able to issue to the SCYC and the concerned DCCs the Map of Final Assessment of Cyclone Hazards (FACH) for guiding the CDMW to be done to the maximum possible efficiency. The FFOs in the State should also issue to the SCYC and the concerned DCCs the Map of Final Assessment of Inundation Hazards (FAIH) for guiding subsequent actions. At this stage in many areas of great danger (AsGD) normal communication channels may snap and the WT system of the Police Department of the INSAT DWS system may have to be used between the concerned ACWC/CWC, FFOs, the DCCs and the CDMW officials/warnees in these areas. So far as action is concerned it can be assumed that during the 'Cyclone Alert' period the SCYC and the concerned DCCs have mobilised all the required personnel/equipments/materials and moved them generally into the areas likely to be ravaged by the cyclone. The 'Cyclone Warning' period will be one of intense activity in those areas over which the cyclone is passing : moving CDMW personnel/equipments/materials close to the path of the cyclone, carrying out evacuation/rescue operations and organising relief camps. The hubs of all these activities would rest at the concerned DCCs which would take all executive actions. The DCCs should therefore be more or less in continuous session during this phase. The SCYCs can only adopt an advisory status at this stage and furnish additional personnel/equipments/materials at a moment's notice if necessary.

2.227 ACTION OF THE CONCERNED ACWC/CWC AND THE FFOs IN THE STATE WHEN THE WARNING IS UPGRADED TO 'CYCLONE WARNING' :

As soon as the warning is upgraded to 'Cyclone Warning' it is expected that the state, should be able to form a difinite idea of the landfall point of the cyclone, its parameters, the direction and extent of accompanying storm surge. It should therefore have made a concrete assessment of areas of alert, danger and great danger. The Cyclone Warning Messages (CWMs) issued should become more specialised and informative at this stage for greater benefit to the warnees.

2.228 ROLE OF THE SCYC WHEN THE WARNING IS UPGRADED TO 'CYCLONE WARNING' :

The Committee recommended :

CRC/145 : When the warning is upgraded to 'Cyclone Warning' the SCYC will constantly monitor the actions of the concerned DCCs and keep a watch on their urgent requirements of personnel/equipments/materials and supply them at a moments notice when requested.

CRC/146 : It is important that the CRGA should now be manned by designated officers of the State Revenue Department, Police Department and Defence Forces.

2.229 ROLE OF THE DEPARTMENT OF GENERAL ADMINISTRATION WHEN THE WARNING IS UPGRADED TO 'CYCLONE WARNING' :

The Committee endorsed the proposal in the Government of Andhra Pradesh*.

CRC/147 : In all CDMWs in which the Defence Department is involved the Department of General Administration of the State Government should take a leading part. Defence Forces will be assisting the civil authorities in evacuation/ rescue operations and running of relief camps. The Department of General Administration will be in overall charge of all this work which involve assistance from the Defence Forces and coordinate these operations.

2.230 FUNCTIONS OF THE CONCERNED DCCs WHEN THE WARNING IS UPGRADED TO CYCLONE WARNING :

The Committee recommended :

CRC/148 : When the 'Cyclone Alert' warning has been upgraded to 'Cyclone Warning', the District Collector after discussing the matter at DCC will take the following actions :

1. Declare formally the areas of Great Danger (Landfall point and neighbourhood), Danger and Alert (AsGD, AsD, AsA). In the AsGD areas must be demarcated and declared to the public as being likely to be

submerged and inundated by the inrushing tidal surge. These areas would possibly be where evacuations may have to be enforced.

2. Put the Fire Brigade, Police, PWD and Public Health Department, P&T Department and the Defence Forces on alert round the clock during the remaining period of the cyclone regime for carrying out specific tasks at a moment's notice.

3. Stop all transports on roads passing through the AsGD at suitable places or direct them to safer routes if possible.

4. Establish communication systems with the officials working on CDMMs which are immune to cyclone, Police WT systems or the INSAT DWS system if that exists in the state. The Superintendent of Police should instal one of the Police WT mobile vans at the CCR of the district for transmitting messages to the affected areas. There should be standing instruction that the staff of the CCR can use on a priority basis any telephone/telephone exchange that is in a working condition.

5. Declare local public holiday for all organisations in the AsGD and AsD. But the officials designated for CDMW and the Departments specially involved in such works do not come under this order.

2.231 HIGHLIGHTS OF FINAL CYCLONE WARNING TO THE COMMUNITY IN AsGD/AsD :

After the 'Cyclone Alert' signal is upgraded to 'Cyclone Warning' level, it is imparative that this warning reaches the AsGD/AsD without fail. The Committee endorsed many of the recommendations given in the Cyclone Contingency Plan of Andhra Pradesh*.

CRC/149 : On receipt of the 'Cyclone Warning' signal the Superintendent of Police should make arrangements to disseminate the warning through the TCCs of the Police Departments : WT, VHF etc. so that all the Police stations upto the Thana level are alerted. It would be the responsibility of the Officer in Charge of a Police Station to transmit the warning to all villages under the jurisdiction of that station.

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* The Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh, Hyderabad (1981).

CRC/150 : The Divisional Engineer, Telephones must communicate the 'Cyclone Warning' message to the various telephone communication hubs in the district. It would be the responsibility of the officer in charge of these communication hubs to transmit message to Village Officers/Executive Officers/ Block Development Officers/Sarpanch/Panchayat Pradhans etc.

CRC/151 : If all the TCCs to the villages fail during a cyclone or if no TCC : telephone, telegram etc. exist upto some group of villages, then the Police Officers in charge of the Thana whose jurisdiction extends over these villages must, after close consultation with the concerned Tahsildars, communicate the 'Cyclone Warning' message through Police Constables/ Special Messengers travelling on foot/cycles/motor bikes/horses or by any other means.

CRC/152 : In the final stages of the 'Cyclone Warning' phase, the village Munsiffs or some official of similar ranks should be given the responsibility of delivering the final warning in the AsDG by ringing the bells in temples/churches and public places which should be audible from long distance.

CRC/153 : The Director of Fisheries should direct his staff to spread the 'Cyclone Warning' message to the fishing community together with advisories for fishermen.

2.232 CAs IN THE SECOND PHASE WHEN THE WARNING IS UPGRADED TO 'CYCLONE WARNING' SIGNAL :

The character of the CAs will change in the second phase becoming more specific and concrete instructionwise and being addressed to specific locations and groups of people. These would differ for AsGD and AsD, the former containing evacuation/ rescue advisories whereas the latter would contain instructions of more general nature about preventive/precautionary/preparatory measures.

2.233 CAs FOR AsD :

The Committee recommended :

CRC/154 : The Cyclone Advisories for AsD must be broadcast very frequently over the AIR. They should be concerned inter alia with the following instructions :

1. People should be requested to monitor with their radio sets, the CB broadcasts of AIR containing the latest warnings of the development/progress of the cyclone, and also the CAs broadcast locally by the State Government Officials and pass on the informations

to others. The listeners should also be instructed that these informations are the most reliable that are available. Thus it is important that the radio receivers in the houses particularly the transistor sets should be fully operational and serviceable.

2. People should be requested to avoid listening to rumours and spreading them.

3. The people must be advised to keep calm and set example to others and help them.

4. Since it is difficult to predict the exact location of the landfall point and the intensity and extent of the storm surge, people should be requested to avoid generally low lying beaches named in the advisories.

5. In regions where there are streams and rivers or river dams, people should be requested to be on alert for dangers of flash floods or dam bursts and avoid possible routes of rushing water released in this manner. Such routes should be clearly named in the CAs by the State Government Officials.

6. If a house is well built and located on high ground in areas likely to be inundated, it is possibly the safest place to stay in during the cyclone regime. The public should be so advised and also instructed to stay on the upper floors and avoid the ground floors. But if the authorities advise evacuation from a particular place, then it must be abandoned with question.

7. People should be advised when going outside their residences to avoid trees, dilapidated/old houses and insecure structures and electrical transmission lines. If on road in a vehicle shelter must be sought at the nearest house without wasting time. In general they should be advised against going outside during a cyclone.

8. The most important thing every body should be advised about is examination of the State of the houses they are residing in. If the foundations/roof do not seem strong enough or the general condition of a house seems unsatisfactory it should be abandoned and the residents seek safer shelters.

9. People who stay on in their residences should be requested to board up glass windows or fix storm shutters in place. For this purpose goof strong wooden planks should be securely fastened. Make

shift and loose boards cause more damage, which fact must be pointed out in the CAs. For doors on outer surface of the houses and buildings strong supports must be provided. If wood planks are not immediately available, paper strips may be pasted on glass panes to prevent splinters.

10. People staying on in their residences should be advised to check loose objects in their houses which may be carried about by the cyclone wind. Thus loose tiles should be secured by cementing. Doors/windows should be repaired. All articles and goods which are likely to be blown off should be tightly secured. In this category are : kerosene tins, cans, agricultural implements, garden tools, hurricanelamps, burning coals from chulas, road signs and similar objects. These when blown may cause great danger to life and property and should be collected and stored in a room away from the rushing winds.

11. People staying on in their residences should be requested to provide for opening of doors and windows on the lee side of the house i.e. away from the wind.

12. The area round the houses should be checked and dead/lying trees should be removed. Movable objects like lumber piles, loose zinc sheets/bricks, garbage etc. lying outside should be anchored and secured.

13. Children, old people and sick persons and patients from hospitals should be directed to go to identified safer places and the authorities should provide all assistance to them for this purpose. If that is not possible, as much safety should be ensured to them as possible under the conditions. Provisions should be made for special food and medicine that they may need.

14. People staying on in their residences should be requested to make provisions for extra food : rice, wheat, flour, grams, potatoes etc. specially of the kind which can be eaten without cooking or with very little preparation : pressed/puffed rice, chhatu, powdered dal etc.. Reserve of cooking fuel and drinking water should also be kept to tide over the period of emergency.

15. Hurricanes/lanterns filled with kerosene, extra stock of kerosene and flash lamps with enough dry cells should be kept in reserve in case of power failures.

16. All house holders should be requested to keep reserve of medicines and preventives against epidemics and they should be advised specifically about what items to keep in stock.

17. Valuable goods should be shifted to the upper floors, if these exist, to prevent damage from the flood water. All furnitures, professional/domestic implements, books, valuable clothes etc. should be put in secure places.

18. The public must be informed that after the wind and rain during a storm, a lull period may follow which does not mean that the cyclone is over. It may be the result of the eye of the cyclone passing over the place, in which case there will be another period of wind in the opposite direction perhaps with greater violence and more rain. So the public must be advised to be watchful and on the alert till the 'Cyclone Dewarning' signal is given.

19. If possible every body must keep contact with the Gram Panchayat Pradhan or the nearest Police Thana and the local Post Office which may have been selected to be local Cyclone Advisory and Operation Centre (CAOC).

2.234 CYCLONE ADVISORIES FOR AsGD :

The Committee recommended :

CRC/155 : These CAs like all others will be broadcast by the State Government over its communication channels. The CAs in AsGD must inter-alia be concerned with evacuation orders. Thus the advisories must contain the following type of instructions.

1. As soon as an area is declared as an AGD people residing there should be advised to leave the area sufficiently early before the approaches to the identified high grounds, the cyclone shelters and the relief/refugees camps are flooded and thus avoid being marooned.

2. Identification of place and time of gathering of people of a particular area in an AGD for collection by the Evacuation Authorities. These places should be made known to the concerned people by the personnel at the local CDMW/CAOC centre.

3. In case it is not possible for the Evacuation Authorities to approach immediately a particular locality, advice must be given to the residents of that locality

to go to an identified place of comparative safety and wait there for further instruction.

4. As soon as the order for evacuation is issued by the District Collector for a particular declared AGD, people must be advised to lock up their residences and leave. For people hesitating to do so, forcible evacuation by the authorities must be carried out. This may be made known to all concerned.

5. The domestic cattle should be set free in time and allowed to seek shelters. The animals have a natural instinct to seek out the safest places. This is perhaps the easiest way of saving them from drowning. On no account should they be tethered or tied up at posts or locked up in sheds.

6. Advice must be given about what the evacuees can carry with them including cattles.

7. If upper floors are available the valuable goods may be removed there before evacuation. Otherwise some possessions, particularly those made of metal can be saved by burying them below ground from where they can be retrieved later when the storm water has subsided making it possible for the refugees to return. Such instructions may be issued by the District Collector in the CAs.

8. Arrangements should be made for the property of the evacuees to be protected against theft and plunder and the people should be assured of this.

9. Assurance must be given by the District Collector that food, medicine and relief would be provided for the cyclone victims and cattle at the cyclone shelters/ refugee camps at all times during and after cyclone emergency.

10. At the evacuee camps at the place of shelters it must be insisted that the instructions of the officers in charge have to be followed. All refugees will be under the camp discipline.

11. It must be insisted that no evacuee may leave the camp unless permitted by the camp commander.

12. The people should be advised that they should keep calm at all stages and that the personal dangers would be minimised if the instructions are obeyed promptly.

CRC/156 : Immediately after hearing of evacuation advisory of the State aGovernment the residents of the notified AGD would take the following actions

1. Secure their movable valuable properties as best as they can : storing in upper floors, burying some underground if that is possible and taking similar measures.

2. Let the cattle/poultry/pets loose and let them seek safer places by use of their natural instinct. The cattle should be marked/branded for later identification.

3. Collect and pack the goods/materials that are permitted to be taken by the authorities.

4. If the roads to the identified shelters are open, to proceed immediately with the family towards these destinations.

5. If the roads are cut off by flood water and if boats are available, to make use of them to go to the directed gathering points for collection by the Evacuation Authorities or to the shelters/refugee camps.

6. If the persons are already marooned, they should make the best safety arrangements as are possible under the circumstances - finding and securing a local shelter, making provisions for emergency food/medicine, trying to arrange distress signals for drawing the attention of the rescue authorities so that they can rush through relief/rescue operations.

7. While at the shelters/refugee camps the discipline there must be strictly obeyed. No body may leave the camps till permitted by the camp commander.

CRC/157 : Adequate Police arrangements should be made at the Cyclone shelters/relief camps/gathering points to see that the refugees are protected against unruly/antisocial elements.

2.235 SUGGESTIONS FOR A FORMAT FOR CAs :

The Committee recommended the following format for the CAs to be broadcast over the AIR.

CRC/158 : The following format may be used for CAs broadcast over the AIR.

FORMAT 2

FORMAT FOR THE CYCLONE ADVISORY (CA) PART OF THE CYCLONE BULLETIN

1. Special Number of the Cyclone : Year X, Month Y, Serial No. Z
2. Authority of issuance of the CA
3. Serial Number of the Cyclone Advisory
4. Date/Time of issuance of the CA
5. Description of Area under warning :

   Warning Status : Alert/Danger/Great Danger/Dewarning/ Nil warning

   Particulars of Warning :

   Cyclone Advisory

   (a) Precautions against flying objects
   (b) Precautions against storm surges
   (c) Precautions against fire
   (d) Protection and storing of moveable property
   (e) Advice about food stock, medicine, fuel for cooking and emergency lights
   (f) Evacuation Orders : Including address/location of Cyclone Shelter/Refugee Camps/ Gathering Points
   (g) Advice about Rescue/Relief/Rehabilitation

6. Nearest Cyclone Advisory and Operation Centre (CAOC) :

   Gram Panchayat Office
   Local Post Office
   Municipality Office
   Police Thana

2.236 CYCLONE SHELTERS/REFUGEE CAMPS :

Since the number of Cyclone Shelters (CYSHELs) may not be enough to handle all the refugees or they may not be sufficiently close to the areas of disaster, it may be necessary to set up relief/refugee camps. The sites must be indicated in advance in the Community Preparedness Plan (paragraph 2.300). Only very general remarks need be made for Cyshels/Refugee

Camps. The permanent Cyclone Shelters (CYSHELs) have been discussed in paragraph 2.300-2.302. The Refugee Camps need to have the same basic facilities provided at the Cyshels (paragraph 2.302), but admittedly these have to be put up at a very short notice as the camps are only of temporary nature. The role of Camp Commanders at these places is very important and sufficient power should be given to them to bear the responsibilities they have to bear. The need for the refugees to submit to the rigid camp discipline has been stressed in paragraph 2.234 - CRC/156. The Committee recommended :

CRC/159 : Though all the facilities provided at permanent Cyclone Shelters can not be provided at the temporary Refugee Camps, the District Collector should ensure the following basic ones :

1. Storage tank for drinking water
2. Emergency diesel generator set
3. Public toilets and water closets
4. Common kitchen and common place of eating
5. Adequate sewerage system immune to storm surge/ floods
6. First aid centre, epidemic fighting centre with public health experts for inspection/advice, medical care unit with trained doctors/nurses/attendants.
7. A TC system immune to cyclone like WT system/ transistor receivers etc.
8. A team of administrative/technical/medical personnel to take care of all problems as they arise. A camp commander must be appointed by the concerned District Collector.
9. Some identifying mark - pennants/baloons in life saving orange colour which are visible from a long distance.

2.237 SPECIFIC MEASURES TO BE TAKEN IN AsGD WHEN THE WARNING IS UPGRADED TO 'CYCLONE WARNING' :

The Committee recommended :

CRC/160 : The District Collector after discussing the matter at the DCC will take the following executive actions in AsGD :

1. Move the evacuation and rescue personnel and equipments and vehicles of the State Transport System and

other commandeered transport vehicles : cars, lorries, buses, boats, launches etc. to the identified points in the district. If necessary the help of the Defence Forces may be sought at this point.

2. About 12 hours before anticipated landfall, forcible evacuation of people and cattle from the AsGD - low lands, littoral areas, deltas and estuaries and islands should start taking them to demarcated places of shelter. The agency mainly responsible for this will be the Police but if necessary the District Collectors may seek help from the Defence forces for men and equipments.

3. Persons in other areas should be informed in the CAs of their respective shelters and gathering points, health centres and relief distribution centres.

4. The houses and properties abandoned as a result of evacuation should be protected against antisocial elements by mobile land and water police as soon as that is possible. Unless public confidence is generated in this matter evacuation may have to be done only by applying force on reluctant people. The Police Department should therefore be asked by the District Collectors to make all efforts to infuse such confidence in the public. If necessary local reliable persons could be mobilised to help in this operation.

5. The organisations like the PWD in charge of public buildings should be requested to inspect them and take suitable actions like strengthening them against immediate dangers of collapse as a result of the fury of the cyclone wind/storm/surge.

6. The public health workers should be moved to their stations and kept on the alert for rendering first aids to cyclone victims and to implement epidemic preventive measures especially in the AsGD where the problems are the same as those resulting from large scale floods caused by rivers or dam bursts.

2.238 MAINTENANCE OF ESSENTIAL SERVICES IN AsGD/AsD (MESV) :

As soon as the warning is upgraded to 'Cyclone Warning' executive actions should be taken by the various departments/ agencies to maintain the essential services in AsGD/AsD. The Committee recommended :

CRC/161 : As soon as the warning is upgraded to 'Cyclone Warning', the District Collector should take all steps to maintain essential services as much as possible. The following steps inter alia must be taken by him.

1. Maintenance of power service : During the actual time of passage of cyclone over any area, it may be dangerous to let the cables through high power transmission towers carry electric power. The State Electricity Board should therefore disconnect the supply of electricity to selected areas in AsGD to prevent accidents and injuries. Also there may be urgent need to have electric power in special public places where hospitals, cyclone, shelters, relief/refugee camps and evacuation routes are located. Generators already moved into places where they are urgently needed should be worked by trained technical personnel. The PWD may be the agency for running these generator sets. The State Electricity Board and similar metropolitan electricity generating organisations should have a master plan according to which protective switches would be operated to take off power from the High Tension lines and rerouting the electric power along safe guarded High Tension lines with a high priority right of way to important places in a cyclonic scene : cyclone shelters, relief/refugee camps, public health centres/hospitals.

2. Supply of drinking water : If there are over head storage drinking water tank, the public water distribution system should be maintained by lifting water to them. It should also be possible to run deep tube wells in the AsGD/AsD through the entire 'Cyclone Warning' period.

3. Supply of minimum food material : At the cyclone shelters, the relief/refugee camps, public health centres/hospitals and for general public consumption enough stock of rice, wheat, puffed/pressed rice, grams, potatoes, cooking media, etc. should be built up. The rationing system for distribution should be tightened up. The Department of Supplies should assign the highest priority to keeping sufficient reserve of food materials at the stores just outside the AsGD so that this can be transported to the CYSHELs/Refugee Camps/distressed people as soon as possible.

4. Supply of kerosene, diesel oil, storage battery : Enough stock of these materials should be available in the normal distribution system. Stocks should be available at the cyclone shelters, relief/refugee camps and public health centres/hospitals and for transports used for evacuation. The Department of Supplies should ensure that sufficient stock of these materials are available for distribution at all the above centres.

5. Supply of medicine and drugs : An adequate supply of the necessary medicines/vaccines/drugs/chemicals for prevention of epidemics should be rushed to the relief/refugee camps/public health centres/hospitals and the stock should be maintained all through the duration of the cyclones and for some time during the post cyclone phase till the camps are disbanded and the refugees return to their homes. Teams of medical men/epidemic experts/paramedical technicians should have by this time moved to their stations at the relief/refugee camps, cyclone shelters, public health centres and hospitals. Departments of Public Health should ensure that these materials are stocked at all the above centres well in advance of the cyclone.

6. Maintenance of the evacuation routes and the essential roads and transports : For purposes of evacuation/ rescue the designated escape routes to the gathering points, relief/refugee camps, cyclone shelters, public health centres, hospitals should be kept open and maintained in usable condition during this phase of the cyclone. The vehicles of the State Transport System and those mobilised from other sources should be maintained in good condition by teams of technical personnel and arrangements made for their garaging and personnel found to drive them. The Department of Roads and Transports should be given all this responsibility. In particular the PWD should ensure that these roads together with the bridges enroute are in good condition or take remedial measures if they are not, well in advance of the cyclone. During the 'Cyclone Alert' phase the PWD would be expected to supervise all operations for keeping the roads clear of obstacles - fallen strees, rubbles etc. The State Transports should be given the special executive responsibility for moving the refugees to safer places.

7. Vigilance over drainage/sewerage systems and river banks/irrigation channels/tanks/hydrodams : It would be the joint responsibility of the Irrigation Department and the Public Engineering Department to take all operational measures to prevent floods. The most important measures would be

   (a) To keep the head regulators of the irrigation system serving the AsGD closed and let the water flow down the river course

   (b) The Village Officers/Surpanches/Panchayat Pradhans would be alerted to intensify patrolling of river banks/irrigation channels/tanks/hydrodams and bring to the notice of the concerned engineers the anticipated locations/moments of possible breaches of the banks/hydrodams for corrective measures to be taken.

(c) The Public Health Engineering Department should keep constant vigilance over the draingge/sewerage system round the places of habitation to prevent water logging and accumulation of flood water and remove promptly all debris blocking these systems.

2.239 REMOVAL OF ALL TRANSPORT FROM THE ROADS PASSING THROUGH AsGD/AsD :

As soon as the signal is upgraded, not only there should be no traffic on the roads passing through the AsGD/AsD but all vehicles on such roads should be directed by the traffic police to places of comparative safety prepared in advance at the direction of the Executive Engineer - Roads and Transport Department. The Committee recommended :

CRC/162 : As soon as the warning is upgraded to 'Cyclone Warning', all vehicles moving on the roads through AsGD/AsD should be directed to move to and wait in places of comparative safety prepared in advance at the direction of the Chief Engineer Roads and Transport Department.

2.240 MEASURES REGARDING TRAINS PASSING THROUGH AsGD :

It is extremely dangerous for the trains passing through AsGD to be moving through cyclones or the passengers on them to be stranded on tracks far away from the Railway Stations. The Committee recommended :

CRC/163 : When the warning is upgraded to 'Cyclone Warning' the trains passing through the AsGD should be brought to rest at the nearest railway station without any waste of time and berthed there till the warning is downgraded.

The relief operations should be started by the Railway authorities and the Revenue authroities for the stranded passengers at the railway stations. The Committee recommended :

CRC/164 : As soon as the trains passing through AsGD have been brought to the nearest railway stations, relief operations should be started by the Railway and Revenue authorities. An enquiry office should be started at these stations with a public address system. Stocks of drinking water, rice, puffed/pressed rice, channa, chapathis, and lemon should be maintained at the stations and milk and biscuits for the children. Medical teams should be posted at the stations. The Station Masters should keep in close contact with appropriate Railway officials at the local/divisional level.

2.241 ACTIONS TO BE TAKEN BY PORT AUTHORITIES ON RECEIPT OF 'CYCLONE WARNING' SIGNAL :

There are a number of immediate measures that the Port Authorities must evidently take immediately on receipt of the 'Cyclone Warning' signal. The Committee endorsed the recommendations of the Cyclone Contingency Action Plan of the Andhra Pradesh Government*.

CRC/165 : On receipt of the 'Cyclone Warning' signal tne Port Authorities should inter alia take the following actions

1. All vessels should be brought into sheltered waters and moored firmly with the masts lowered down.
2. Some of the bigger vessles if denied safe births at the ports due to lack of space may be advised to move out to demarcated areas on the open sea, if there is time, where they may be safer than in the ports.
3. The general precautionary measures advised for cyclone - safe guarding of electrical installations such as substations, barricading of doors/windows/ other openings in buildings and securing of movable objects etc., should be immediately put into operation.
4. At the discretion of the Port Master, the electrical power may be cut off during the duration of the second phase of the emergency to avoid casualties from overturned electric poles and exposure to live wires. All transmission towers should have been strengthened during the 'Cyclone Alert' period or earlier.
5. Booms of all cranes and similar machineries should be lowered and put to rest on the ground.
6. All the general cyclone precautionaries recommended to make buildings safe against cyclones should be immediately applied to all godowns/sheds in the port.
7. The appropriate storm signal should be hoisted which should be kept up to date every time new information is received over the CBS broadcast by AIR of from the concerned ACWC/CWC or from the Port Meteorological Office (PMO).

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* The Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh, Hyderabad, 1981.

V.D(3) CODE OF CYCLONE MEASURES TO BE TAKEN AFTER 'CYCLONE DEWARNING' SIGNAL IS BROADCAST - THE THIRD PHASE

2.242 'CYCLONE DEWARNING' SIGNALS ISSUED BY THE ACWC/CWC AND BY THE AIR :

After the cyclone has weakened it is necessary that the public must be immediately informed of the passing of danger. In paragraph 2.172 the Committee has recommended that the ACWC/CWC should issue the 'Cyclone Dewarning' message to the AIR after the cyclone for broadcast to the public (recommendation CRC/97). The Committee further recommended :

CRC/166 : After the cyclone has weakened, the ACWC/CWC should send the 'Cyclone Dewarning' signals to the SCYC, which in turn should relay the message to the concerned DCCs. The concerned CCRs should then issue the 'Cyclone Dewarning' signal to all the units of the CDMO which in turn should transmit the message to officials like Gram Panchayat Pradhans, Chairman of the City Municipalities, concerned officers of the State Government - Police officers etc. and the concerned officers of the Central Government - P&T officers, Defence units working in the locality etc. This would confirm the 'Cyclone Dewarning' message broadcast directly by AIR.

CRC/167 : After the 'Cyclone Dewarning' signal has been issued, the concerned ACWC/CWC should issue a summary of report of the various aspects of the cyclone through the medium of AIR so that the affected population and various groups of warnees are aware of all that has happened.

2.243 FEATURES OF THE PHASE 3 OF THE CDMW AFTER THE CYCLONE DEWARNING SIGNAL IS ISSUED :

After the 'Cyclone Dewarning' signal is received it is to be expected that main brunt of wind and storm/surge is over. There will be large areas submerged under storm/flood water cutting of and marooning large groups of people. The Cyclone Shelters and Refugee Camps at the AsGD are expected to be crowded with people who have abandoned their homes and who may have brought some cattle/pet animals with them. The Essential Services in many areas may have closed down and normal life suspended. There may be large scale destruction of agricultural crops/trees/public utilities/houses and buildings and lockage of public sewers/water drainage system. The main tasks in phase 3 would therefore be inter alia

1. Rescue of marooned people
2. Restoration of essential services
3. Restoration of normal life

4. Relief to cyclone victims
5. Rehabilitation of cyclone victims
6. Review of damages caused by cyclones
7. Reconstruction programmes

2.244 VARIOUS PHASES OF THE CYCLONE DAMAGE ASSESSMENT (CDMA) :

It is clear that CDMA has to be done in three stages :

1. First stage of CDMA : The objective is mainly to assess the damages/dislocation of life and population to the extent necessary for working out plans for
   (a) Rescue of marooned people
   (b) Restoration of essential services
   (c) Restoration of normal life
2. Second stage of CDMA : The objective now would be to have a full assessment of the damages - both in physical and economic terms in order to provide a base for the affected State Government to provide Relief/Rehabilitation/Reconstruction funds out of its own resources or from the Central Government for providing
   (a) relief in terms of cash or materials as outright grant or loans on short/long term basis to the cyclone victims for their rehabilitation
   (b) Reconstruction/Repair of damages done to public utilities
3. Third Stage of CDMA : The objective is to prepare the final report on the cyclone for the purpose of records. This review would include
   (a) Full description of the cyclone
   (b) The success/failure of the CMS
   (c) The success/failure of the CWS
   (d) The success/failure of CDMW
   (e) The CDMA of (2) above in terms of physical/ economic loss
   (f) The cost of Relief/Rehabilitation Reconstruction

The first CDMA would be the responsibility of the concerned District Collector, the second that of the Collector - Revneue Department of the concerned State and the third should be the joint responsibility of the IMD and the Revenue Department of the affected State. The first stage CDMA is discussed in the next paragraph 2.245. The second and third stage CDMAs are discussed in paragraphs 2.266 and 2.273.

2.245 FIRST STAGE CDMA :

The Committee recommended :

CRC/168 : Immediately after the receipt of the 'Cyclone Dewarning' signal, the concerned District Collectors should start the First stage Cyclone Damage Assessment (CDMA) which must be completed as soon as possible so that Rescue/Relief/ Restoration works may start. The main object of this assessment is mainly to

1. review the state of the TCCs from the CCRs to the units of the CDMW in the affected areas upto the village/city levels that may have been snapped by the cyclone

2. locate the areas that have been cut off i.e. which can be approached only by boats or after clearance of debris on the roads leading to them and determine the number of marooned people/cattle in these areas

3. estimate the number of refugees already in the CYSHELs/Refugee Camps and quantify their basic needs : food/clothing/medicine etc.

4. estimate the number/locations of the public utilities put out of operation whose restoration is urgently for reviving the essential services

5. examine specially the public health engineering system and assess the locations where epidemic may break out

6. estimate the number and location of dead bodies lying on roads and other places that have to be removed.

CRC/169 : Since most of the areas where cyclone victims are marooned can not be approached if boats or powered launches are not available in sufficient numbers, the quickest method of locating these areas would be by aerial survey of the affected areas by the planes of the IAF.

The concerned District Collectors should request the concerned ACWC/CWC for satellite pictures of the area and the Commanding Officers of the Headquarter of IAF in the State for the aerial survey.

CRC/170 : The concerned District Collectors should send to the P&T Department the list of the TCCs in the units of the CDMW in the affected areas that are nonoperational and request the Department for prompt restoration of these channels. They should also make every effort to despatch inspectors to these units to receive the local reports on the TCCs and receive a first hand impression of the damages done by the cyclone.

CRC/171 : The District Collectors of the ravaged areas should set up at their respective CCRs Cyclone Damage Maps for the regions under respective jurisdictions in order to have a firm basis for planning strategies for Rescue/Restoration works there.

CRC/172 : Immediately after the 'Cyclone Dewarning' signal the concerned District Collectors should start the First State CDMA and get the first reports of the locations of the marooned persons and damages caused by the cyclones. For this purpose assessment teams led by Tahsildars and Deputy Tahsildars should visit the spots indicated by aerial serveys.

2.246 RESTORATION OF ESSENTIAL SERVICES (RESV) :

The immediate task of the District Collectors of the ravaged areas would be the restoration of the essential services (RESV) as soon as possible so that it can be possible to carry out the planned operations for Rescue and Restoration of normal life. The important items of RESV operations are

1. Restoration of TC.
2. Restoration of roads, repair of bridges and clearance of debris lying on them.
3. Restoration of electric power and repair of electricity transmission lines.
4. Removal of storm/flood water.
5. Repair of breaches of hydrodams/water reservoirs/ tanks/bunds etc.
6. Restoration of the Railway system.

The various items will be discussed in detail in paragraphs 2.247-2.253.

2.247 RESTORATION OF THE TC SYSTEM :

The restoration of the TC system if damaged by the cyclone is the most important single item in RESV for without a communication system the State Authorities would have no knowledge of the local situations in the affected regions. The Committee recommended :

CRC/173 : All snapped TCC links - Telephone, Telex, TP etc. should be restored by the P&T Department which should assign to this responsiblity the highest priority.

2.248 RESTORATION OF ROADS AND BRIDGES :

To enable free movement of land transport for carrying relief materials it is necessary to restore the roads and repair the bridges and clear them of the debris spread by the cyclone. The Committee recommended :

CRC/174 : The District Collector should ensure that immediately after a cyclone all rubbles and debris from collapsed houses and buildings etc. should be removed expeditiously in the village/city areas to restore communication. The PWD Department should undertake this work.

CRC/175 : Immediately after a cyclone the District Collectors should ensure that Roads Department take immediate steps to remove the fallen trees. The villagers may be permitted to gather and remove these trees if they can do that quickly so that roads can be cleared without loss of time. For cutting/sectioning these trees local labour/local equipments should be mobilised. The whole work would be done under the direction of the District Collectors who should be given absolute discretion in the matter. Mobile squads and vehicles should be commandered to carry away these trees.

CRC/176 : The PWD should set up immediately after the cyclone squads of engineers/workers with the necessary equipments/materials to repair the damaged roads and bridges quickly at least on a temporary basis to permit resumption of transport systems by roads. The District Collectors in the affected regions must be informed by the PWD when the roads/bridges have been repaired.

2.249 RESTORATION OF ELECTRIC POWER :

For resumption of normal life and running of many public utilities restoration of electricity must be done as soon as possible. The Committee recommended :

CRC/177 : The District Collectors of the cyclone ravaged areas should issue suitable warnings to the public against playing with loose dangling electrical wires from electric lamp posts and high voltage transmission towers. The nearest authorities should be informed immediately when their existence is detected. The State Electricity Board/Other Electric Supply Organisation should take immediate steps on receipt of the 'Cyclone Dewarning' signal to clear the roads of uprooted electric poles and fallen electricity transmission towers and restore supply of electricity to all consumers as soon as possible. The District Collectors of the concerned a areas should be informed of all these actions as soon as they are completed.

CRC/178 The order of priority of restoration of electric power should be in the following order : (1) AIR, (2) Water Works, (3) Hospitals, (4) All Relief Camps/Cyclone Shelters/Relief Centres, (5) Public Health Engineering Works, (6) Railways and Ports, (7) Government Offices connected with the CDMW, (8) Private Residences, (9) Agriculture, (10) Commercial concerns - Markets/Stores, (11) Industries, (12) Public Utilities.

2.250 REMOVAL OF STORM/FLOOD WATER :

A major obstacle to transport and communication would be water logging over large tracts of land due to heavy rain/ storm surges. Efforts must be made to remove this water as early as possible. The Committee recommended :

CRC/179 : The concerned District Collectors should arrange installation of mobile pumps at strategic places/ remote points to drain out the standing water from the fields and roads and places of habitation in the inundated areas, and route it into drainage channels, and river ways immediately after the cyclone has passed.

CRC/180 : Squads formed by the Public Health Engineering Department should inspect all drainage installations in the areas ravaged by the cyclone to see that they are in good working conditions. Any necessary repairs and technical problems that may arise therefrom should be solved by this Department so that the standing water can be removed promptly.

2.251 REPAIR OF BREACHES OF HYDRODAMS/WATER RESORVOIRS/ TANKS/BUNDS ETC. :

There may be considerable breaches in various water storage systems in the affected areas - hydrodams/water resorvoirs/tanks/bunds etc. on account of fury of the great rush of water caused by the cyclone. Immediately after receipt of the 'Cyclone Dewarning' signal these must be repaired at least on a temporary basis so that there is no further addition to the standing water. More permanent repairs have to be postponed till the second stage of the CDMA is completed and an estimate can be made of the cost of these repairs. The Committee recommended :

CRC/181 : The District Collectors of the ravaged areas should collect informations about all the breaches of the water storage systems in these areas - hydrodams/water resovoirs/lakes/tanks/bunds etc. which are causing input to the standing water resulting from the precipitation caused by the cyclone. Attempts should be made to repair these breaches at least on a temporary basis so that essential services can be restored. The concerned District Collectors should request the PWD to undertake such repairs immediately. The Department of Supplies should provide all the materials necessary for these repairs.

CRC/182 : Permanent repairs of the breaches of the water storage systems in the affected areas may wait till the second stage of Cyclone Damage Assessment has been completed so that an estimate can be made of the budgetary provisions that may be necessary. These repairs can be undertaken at a normal pace in due course.

2.252 RESTORATION OF THE RAILWAY SYSTEM :

It is necessary to restore the running of the passenger/goods trains which are stranded at the various stations during the second phase of the CDMW (Cyclone Warning period) so that the passengers can go to their destinations and the commodities essential for Relief/REhabilitation and Restoration of normal life may move freely to where they are needed. The Committee recommended :

CRC/183 : The District Collectors of the affected areas should have complete informations about the whereabouts of the stranded trains and the schedule of moving them to their destinations.

CRC/184 : The Railway Department should immediately inspect the nature/location of damages to the tracks caused by the cyclone and take prompt steps to repair them.

CRC/185 : The Railway Department should restore normal traffic of passenger/goods trains as soon as possible.

CRC/186 As long as the Railway Department can not arrange normal running of the trains it should consider each railway station in the affected area as a Relief Camp and provide all relief to the stranded passengers as is arranged in other Relief Centres. It is important to have Public Address Systems installed in each of these stations to inform the public of the latest position about train movements/ disseminate relief advisories.

CRC/187 : The Railway Department should make every effort to start the trains moving from where they have been stranded after the tracks have been repaired or by diversions to alternative routes. A senior Railway Officer of the Division should be given the responsibility of taking all decisions about restoration of the Railway service.

CRC/188 : The Railway Department should arrange trains/ waggons for movement of relief materials and cyclone victims to Relief Centres/Cyclone Shelters/Refugee Camps.

2.253 RESTORATION OF NORMAL LIFE :

In the AsA and AsD normal life can be and should be restored without wasting time. To certain extent this can be done in the AsGD after the RESV operations are successfully completed. The sooner this can be done quicker would the confidence of the people return. Some steps can be taken by the authorities to restore normal life. These are described in paragraphs 2.254 to 2.257. Other measures are discussed under the general heading - Prevention of epidemics in paragraph 2.264.

2.254 OPENING THE REPAIRED ROADS/BRIDGES TO NORMAL TRAFFIC :

As soon as the damaged roads have been restored, road traffic should be allowed to move on them. The Committee recommended :

CRC/189 : As soon as the cyclone ravaged road/bridges have been restored, these should be opened to all the normal types of transports : lorries/buses/taxis/private motor cars etc. In particular these roads can be used by the various requisitioned for evacuation/rescue operations for the marooned persons. Road signs should be prominently displayed to inform the public whether the roads are useable or not.

2.255 RESUMPTION OF A NORMAL TRADE/COMMERCE :

As soon as goods and commodities are permitted to move by roads/trains/waterways, normal trade and commerce may resume. The Committee recommended :

CRC/190 : The State Authorities should arrange normal trade and commerce to resume as soon as it becomes possible for goods and commodities to move freely by roads/railways/waterways to the normal market places. High priority must be given to bring into the market items like food/fuel/medicines and materials for repair of damaged houses : bamboos/cement/sand/bricks/agricultural seeds/professional tools.

2.256 MAINTENANCE OF LAW AND ORDER :

Criminals are expected to be very active in the period of chaos after the cyclones because of inaccessibility of the cyclone affected areas to the authorities due to damages of roads and bridges or because of standing water. The Committee recommended :

CRC/191 : The Police should increase their vigil and patrolling and guard duties to ensure security to life and property of cyclone victims.

CRC/192 : Identified antisocial elements should be rounded up during the period of the cyclone to prevent looting and plundering of property and commission of other crimes.

2.257 RETURN OF CYCLONE REFUGEES BACK TO THEIR RESIDENCES :

The return to normal life can be said to be complete only when it becomes possible for the cyclone victims to return to their homes. The Committee recommended :

CRC/193 : The District Collector should organise orderly return to their homes of the cyclone victims, evacuated to Cyclone Shelters/Refugees Camps. For this purpose all help must be given to the refugees, the most important of which is transport. The vehicles of the State Transport Corporation can be put to use in this operation.

2.258 HIGHLIGHTS OF RESCUE OPERATIONS :

The most important item of phase 3 of CDMW is the rescue of the cyclone victims from where they have been marooned. This operation is being discussed after RESV operations only because no rescue operation can be effective till the roads leading to the marooned people become possible once again. Indeed the rescue operations must go on simultaneously with RESV operations. The objective of rescue operations is to detect the location of the marooned people (discussed in paragraph 2.244), collect them and bring them to Cyclone Shelters/Refugee Camps for relief.

2.259 RESCUE TEAMS/RESCUE OF MAROONED PEOPLE :

Rescue operations need a high degree of expertise and sophistication for effectiveness and the personnel who have to undertake these responsibilities need some preliminary training. This matter is discussed in paragraphs 2.309. The Defence personnel have a very high degree of training in this field and it is advisable for the conerned District Collectors to appeal to the Defence Authorities for help for this purpose at this stage. The Committee recommended :

CRC/194 : As soon as the areas where the cyclone victims have been marooned have been detected from aerial survey the concerned District Collectors should if necessary appeal to the local Defence Authorities for help in rescuing the marooned people.

CRC/195 : The District Collectors should convene a meeting of the DCC after the 'Cyclone Dewarning' signal to discuss and prepare rescue plans. They should also prepare maps showing the location of the Cyclone Shelters/Refugee Camp to which the cyclone victims from a particular zone have to be transported. These Rescue Operation Maps should be put up at the CCRs.

CRC/196 : Rescue teams should be formed promptly after the 'Cyclone Dewarning' signal, from State Government Officials trained in rescue operations and units of the local Defence Organisation/Divil Defence Department/Coast Guards. All equipments necessary for rescue operations should be issued from the nearest Cyclone Store by the concerned District Collectors.

CRC/197 : Transport vehicles : Buses/lorries/tempos/cars/or powered launches/boats/country boats which have been already commandeered should be put at the disposal of the Rescue Teams by the concerned District Collectors as and when demanded. The types of vehicles to be used should depend on the nature of the terrain and the state of distress of the cyclone victims.

CRC/198 : The Department of Irrigation/the Defence Authorities should be able to provide sufficient number of powered launches/amphibian vehicles for Rescue/Relief Operations. Similarly the State Transport Department/Private Transport Organisations should be able to provide the buses/lorries/tempos needed for the same operations. The concerned District Collectors should make use of all these sources to collect the necessary transport vehicles and build up the Rescue/Relief Organisations quickly without loss of time.

The concept of Cyclone Store has been discussed in paragraph 2.306.

2.260 AIR DROPPING OF RELIEF MATERIALS TO CYCLONE VICTIMS WHO CAN NOT BE REACHED :

In spite of the best efforts there will be many pockets of cyclone victims which can not be reached for considerable time. This will be the situation almost everywhere in the immediately after the cyclone has passed. It would therefore be necessary to distribute relief materials : food packets/ medicines/chemicals for epidemic control and also to evacuate those who are seriously sick/injured. In such situations it is best to call for help from the local Defence authorities. The Committee recommended :

CRC/199 : The concerned District Collectors should call upon the local Defence Authorities to arrange aerial dropping of precooked food packets/medicines/chemicals for epidemic control and evacuate by helicopter those who are seriously ill/injured in areas which can not be reached by the rescue teams. Trained officials of the State Government can be transported by air to these areas to take control of the cyclone victims gathered there.

2.261 HIGHLIGHTS OF RELIEF OPERATIONS :

After the cyclone victims have been brought to the prepared Cyclone Shelters/Relief Camp the Relief Operations would start. There are three parts in Relief :

1. Immediate Relief : This is a matter for the State Government Authorities to see that the refugees at the CYshels/Refugee Camps have reasonable comfort and medical care. This will be discussed in paragraphs 2.263 and 2.264.

2. Cash Relief : This is to enable the refugees to go back to their residence when conditions permit and have the money for such repairs to their houses/ other facilities enabling them to live there and also have some subsistence allowance till they can stand on their own legs. This will be discussed in Section V.E and specifically in paragraph 2.275.

3. Long Term Relief : The objective of this Rehabilitation of the Refugees. This will be discussed in Section V.E paragraphs 2.278-2.282.

2.262 APPEAL TO SOCIAL SERVICE ORGANISATIONS AND CHARITABLE BODIES FOR HELP IN RELIEF AND REHABILITATION WORK :

There are many Social Service Organisations (Red Cross Society etc.) and charitable organisations who have very wide experience of relief work after natural disasters. It is advisable that the concerned State Government appeal to them at this stage for direct participation in the Relief Works. The Committee recommended :

CRC/200 : The State Authorities should call for help/ direct participation from social welfare organisations and charitable bodies in the relief and rehabilitation work among the cyclone victims necessary after a cyclone and in particular for volunteers to work with the State Government Officials.

CRC/201 : If the preliminary assessment of the damages caused by the cyclone appear to be very large, the District Public Relation Officer of the concerned State Government should issue appeals for voluntary donations of money/relief materials and make arrangements to receive them.

2.263 RELIEF CENTRES/RELIEF TEAMS :

For proper and efficient distribution of relief, Relief Centres have to be established either in close proximity of the Refugee Camps or at the Gyshells. The Committee endorsed the recommendations of the Andhra Pradesh Government* about the various modus operandi.

CRC/202 : Relief Centres should be established in close proximity of the Cyclone Refugee Camps or at the Cyclone Shelters and put under the control of empowered State Government Officers.

CRC/203 : All cyclone relief materials :

1. Stock of food materials : rice grains, wheat, flour, dals, various vegetables - potatoes, cauliflowers, cabbages etc., cooking spices/masalas-chillies, tamarind, turmeric powders, cooking media : oils of various types - mustard, coconut, rape seed oil, groundnut oil, cooking fuel : kerosene, coal etc., cooking utensils and other accessories

2. Hurricanes, lanterns, hazzacs with adequate stock of fuels

3. Common medicines and medical treatment accessories

4. General medicines/chemicals for epidemic control

should be stored by the Civil Supplies Department, Food Corporation of India and similar organisations at the Relief Centres for distribution to the various Refugee Camps/Cyshels. For distribution of these materials the lorries should be brought to the Relief Centres for loading and then the destination slips given to their drivers to take the materials to the Refugee Camps/Cyshels and to those villages whose residents need these materials urgently.

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* Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh, Hyderabad, 1981.

CRC/204 : The CCRs of the District Collectors should keep a close watch on the requests for the relief materials and their prompt distribution. It must be seen by the District Collectors that in such procurement/distributions no time is lost.

CRC/205 : Relief Teams will be formed by the concerned District Collectors with State Government Officials and volunteers from Social Service Organisations/Charitable Bodies to carry out the actual Relief Work at the Cyshels/Refugee Camps or at the actual villages ravaged by the cyclone.

CRC/206 : All State Officials/Volunteers from Social Service Organisations/Charitable Bodies, and members of Rescue/ Relief teams should report their activities to the concerned District Collector atleast twice daily and keep the CCRs/ Tahsildars informed of their position/movement in the affected areas.

2.264 PREVENTION OF EPIDEMICS :

Epidemics inevitably follow in the wake of disasters like cyclones/floods etc. and prompt steps must be taken immediately after the 'Cyclone Dewarning' signal. The Committee recommended :

CRC/207 : The concerned District Collector in colaboration with the Police Department should form squade to remove/dispose of the dead bodies and carcasses of animals immediately after the 'Cyclone Dewarning' signal before their decomposition sets in. Attempts should be made by Missing Person Enquiry Offices formed by the District Collector with the help of the village officials - Gram Panchayat Pradhans and the local surviving people.to identify the names of the dead persons before final disposal. Final disposal of dead bodies may pose difficulties and what may have to be ultimately done is mass burial/funeral. The District Collector should make all arrangements for such disposals - providing of transport for removal of bodies, fuel like coal/kerosene etc.

CRC/208 : The District Medical and Health Officer should send teams with the necessary drugs/vaccines/chemicals to the ravaged villages/Refugee Camps/Cyshels for carrying out a programme of (1) mass vaccination, (2) distributing necessary palliatives and vitamins, and (3) implementing epidemic control measures specially against spread of cholera/dysentary. At the cities the City Municipal Authorities should take up this responsibility through their officials.

CRC/209 : Wells and water tanks which may provide drinking water to the people living in the affected regions, particularly in the villages/Refugee Camp/Cyshels should be tested by the Public Health Engineering Department after the cyclone. Those sources with plluted water should be clearly marked out by prominent notices and people warned against using them. A vigorous programme of Chlorinisation of the water at these sources should be undertaken immediately by teams of public health workers under the direction of the District Medical and Health Officer.

2.265 ENQUIRY OFFICES FOR THE FATE OF MISSING PERSONS :

The Committee stressed the need of informing the relatives and friends about the names of cyclone victims - dead, injured or missing. In recommendation CRC/207 it was stated that attempts must be made to identify the dead persons before final disposal of their offices. Enquiry offices should be set up at all the centres of CDMW/Cyclone Advisory and Operation Centres (CAOCs)/Cyclone Shelters/Refugee Camps/public places. As soon as lists of dead/injured/missing persons can be prepared they should be exhibited at all these places. All this work should be started immediately with the disposal of the dead bodies and completed before the Cyclone Damage Assessments are done. The Committee recommended :

CRC/210 : Enquiry offices should be set up by the District Collectors for giving informations about dead/injured/missing persons at all centres of CDMW/Cyclone Advisory and Operation Centres (CAOCs)/Cyclone Shelters/Refugee Camps/public places. As soon as the list of these persons can be prepared they should be exhibited at all these places. The work should start with the disposal of dead bodies and preparation of list of refugees at the Cyclone Shelters/Refugee Camps and finish before the second stage of Cyclone Damage Assessment (CDMA) is started. The assessment of dead/injured/missing persons should be handed over to the second stage CDMA teams for entering into the Cyclone Damage Assessment Form 1 referred to in CRC/212.

This is the first step to be taken before Form 1 can be filled up.

2.266 THE SECOND STAGE CDMA :

Before the question of distribution of short term/long term monetary relief to be given to the cyclone victims can be considered, it is necessary to have a full report on the physical/economic damages caused by the cyclone. As soon as possible after the rescue operations are over and the refugees are more or less settled at the Cyclone Shelters/Refugee Camps, the second stage CDMA should start. The Committee recommended :

CRC/211 : After the refugees are well settled in the Cyclone Shelters/Refugee Camps, the concerned Divisional Revenue Officer should form Cyclone Damage Assessment teams to visit the ravaged areas to assess the physical/economic damages caused by the cyclone. Each team should include a Gazetted Officer and another officer not below the rank of Deputy Tahsildar. The assessments should be entered in prescribed forms supplied to the teams and submitted to the Divisional Revenue Officer.

2.267 SCOPE AND NATURE OF THE SECOND STAGE CDMA

The Committee endorsed the recommendations about the scope and nature of the assessment of the cyclone damages*. A rearranged extended version of this recommendation of CDMC is given in what follows :

CRC/212 : The Cyclone Damage Assessment Formats cover the total damage caused by cyclones and tropical depressions and associated heavy rainfalls and the storm surges, floods and Landslides. There should be damage assessments to be recorded in two parts, both following the recommendations of ESCAP :

1. Form 1 : to cover the description of the physical damages in terms of injury and loss of life and cattle, and damage of property caused by wind and water.
2. Form 2 : to cover the damages in various sectors of the economy.

Both forms should be filled up by direct inspection to the extent possible and not from press reports not verified from authoritative sources or from reports from untrained observers.

2.268 SUGGESTIONS FOR A FORMAT FOR THE SECOND STAGE CDMA WITH RESPECT TO PHYSICAL LOSSES INFLICTED BY A CYCLONE

The Committee endorsed the recommendation by CDMC (CDMC-Report Appendix).

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* Final Report of the Cyclone Distress Mitigation Committee - Andhra Pradesh : Appendix Office of the Chief Engineer (Major Irrigation) Irrigation Branch, Hyderabad (1971).

CRC/213 : The Cyclone Damage Assessment Form I (Physical Damage) should have the following format

FORMAT 3

FORM I

PHYSICAL DAMAGES CAUSED BY CYCLONES

1. Cyclone Serial Number

2. Cyclone Regime - Dates/time

3. Region of Survey :

    Geographic Description
    Number of villages
    Number of towns

4. Date of Survey

5. Sources of Information

6. Casualties (Numbers)

    A. Human Lives

        (a) Number Dead

        (b) Number of Missing

        (c) Number Injured

        Subtotal ____________

        (d) People affected

            (i) Number of Families

            (ii) Number of Persons

    B. Livestock :
    Cattle/poultry/pet

        (a) Number of Dead

        (b) Number of Missing

        (c) Number of Injured

        Subtotal ____________

        (d) Domestic animal population affected

        Cattle/poultry/pet

7. Crop destruction/damage

    Name of Crop destroyed

    Area with the damaged crop (Hectare)

    Total cultivated area
    with the crop (Hectare)

    Estimated damaged crop

    Estimated Potential Yield

8. Loss of trees (in number)

    (a) in orcards

    (b) others

Subtotal ____________

9. Houses and Buildings damaged/ destroyed (number)

A. Huts

    (a) Number completely destroyed

    (b) Number damaged

B. Residential Buildings

    (a) Number completely destroyed or washed away

    (b) Number partially destroyed or submerged above plinth level

    (c) Number submerged below plinth level

Subtotal ____________

C. Non-residential Buildings

    (a) Number completely destroyed or washed away

    (b) Number partially destroyed or submerged above plinth level

    (c) Number submerged below plinth level

Subtotal ____________

10. Damage to Public Utilities

    Type of utility damaged

    Nature of damage

11. Loss to fishermen

    Boats lost

    Loss of fishing equipments

12. Inundated and/or area with damaged crop/houses (in hectare)

    (a) Cultivated land

    (b) House lots

    (c) Others : industrial complexes etc.

Subtotal __________

13. General Remarks

Signature of
Assessment Officer

2.269 SUGGESTIONS FOR FILLING UP THE SECOND STAGE CDMA FORM 1 :

The Committee endorsed the suggestions of the CDMC about how the Form 1 should be filled up :

CRC/214 : The following points may be kept in mind while filling up Form 1 of Cyclone Damage Assessment :

1. Casualties should be entered in rows 6A(a), (b) and (c). 'Dead' means confirmed deads or presumed to be dead (row 6A(a)). 'Missing' includes who have not been traced after the cyclone but whose death can not be presumed (row 6A(b)). 'Injured' encompasses all those injured regardless of the seriousness of the injury (row 6A(c)). 'Population affected' include the homeless, evacuees, and in Cyshels/Relief Camps i.e. these qualifying for assistance for relief and rehabilitation as also those whose routine of normal life has been snapped (row 6A(d)).

2. Casualties under rows 6B(a), (b) and (c) similarly include livestock : cattle, poultry and pet animals dead, missing and injured (row 6B).

3. Under row 7 the loss should be recorded under each type of crop : rice, wheat, potatoes etc. Not only should the areas covering the total cultivated land in the cyclone ravaged area by entered under 7 but also the areas bearing the crops damaged by wind and water must be entered. If possible the estimates should also be made of the total potential yield of a particular crop in the ravaged area but also of the damaged crop so that if possible to speak in terms of percentage losses. The area of damaged cultivated lands should be used to estimate monetary value of crop damage by multiplying the area covered by the particular agricultural product, if direct estimate can not be made of the damaged crops, and the appropriate unit price of the commodity.

4. Loss of fruit bearing trees can be similarly converted (row 8(a)) from the number lost into equivalent money value. Loss of other trees should also be recorded to assess the ecological disturbance (row 8(b)). Under row 8(a) would also come things like coconut trees/ palms/casurina trees etc. which dominate the landscape in the coastal regions. Also must be considered fruit trees like mango trees/bannana plantations/vine yards etc. which are found all along the eastern coast.

5. Huts under 9A will be almost all in the villages. 'Buildings affected' (rows 9B and 9C) are classed as 'residential' and 'nonresidential'. Under the classification 'residential' comes private houses, Government buildings, schools, libraries, community centres, places of worship, hospitals, hostels, hotels etc. Under 'nonresidential' is included storehouses, garages outhouses etc. Under row 9(a) B&C those buildings are entered that can not be used any more and must be reconstructed. Row 9(b) A&B should cover those buildings that can be repaired for reuse.

6. Under row 10 will come description of damages to all public utilities - roads/bridges, electricity generation/transmission systems, hydrodams/bunds/dykes/water reservoirs/irrigation heads, water drainage/sewerage systems, etc. The physical damages only would be recorded : total destruction, severe damage, light damage.

7. Under row 11 would come loss of fishing boats/fishing equipments like nets/navigation aids and fishing catches.

8. Under the heading 'inundated and/or area with damaged crops/houses' the most important item is that related to cultivated land (row 12(a)) including paddy fields and crops and those with various house lots, industrial areas and other areas inundated which should be recorded

in row 12(b) and 12(c) for future guidance during reconstruction when land zoning controls may have to be applied. Also valuable guidance can be obtained for the future from this record for predicting storm surges and floods if this data can be correlated with cyclone parameters and rain falls.

2.270 SUGGESTIONS FOR A FORMAT FOR THE SECOND STAGE CDMA WITH RESPECT TO ECONOMIC LOSSES INFLECTED BY A CYCLONE :

The Committee endorsed Form 2 recommended in CDMC Report - Appendix. The following is a variation of the format recommended by the CDMC.

CRC/215 : The CDMA Form 2 (Economic Loss) should have the following format.

FORMAT 4

FORM 2

CYCLONE DAMAGE ASSESSMENT OF ECONOMIC LOSSES (IN LAKHS OF Rs.)

1. Cyclone Serial Number
2. Cyclone Regime : Dates/Time
3. Region of Survey : Geographic Description
   Number of Villages
   Number of Towns
4. Dates of Survey
5. Sources of Information
6. Loss of livestock
7. Loss of agricultural products/
   Loss to Agriculture Department Store
8. Loss of private property
9. Loss of Government/local/municipal properties
10. Industrial loss
11. Loss of public work facilities : Irrigation/Electricity/Drainage/Roads/Bridges/Water Storage Systems

12. Loss of public utilities

13. Total loss in Monetary terms

Signature of Assessment Officer

2.271 SUGGESTION FOR FILLING UP THE SECOND STAGE CDMA FORM 2 :

The Committee also endorsed the explanations given by the CDMC (CDMC Report - Appendix) of the items appearing in Form 2 of CDMA :

CRC/216 : The items appearing in Form 2 of CDMA must be understood in following terms :

Row 6 : Loss of Livestock : Loss of livestock would include estimates of the price of all cattles/poultry/pets killed by the cyclone. The estimates may have to be indirectly estimated by judging the loss of cattle etc. by drowning and burial under debris. A direct assessment based on reports from the surviving victims tend to overstress the losses.

Row 7 : Loss of agricultural Product : This item includes loss of

1. Rice crops, vegetables, fruits

2. Marine products

3. Forest products

4. Loss due to suspension of agricultural activities

The group (Row 7) generally constitutes a high proportion of total flood damage. The crop damage may be estimated by assessing the area under a particular crop damaged and the average loss of that crop per hectare and then summing up the amounts for all the crops. In estimating damage in terms of money the unit price of various types of crop have to be considered. Crop damage must be estimated by assessing the extent of damage due to inundation and burial under debris. Loss of livestock may be similarly estimated.

5. Materials stocked in Agriculture Stores - Cut crop/ seeds/fertilisers/insecticides/fungicides/agriculture equipments etc.

Row 8 : Loss of property : This includes

1. Houses and buildings

2. Household articles

3. Stored goods : Tools and equipments of farmers etc.

These should be estimated by surveys and listings. If possible the number of houses and buildings, their floor areas and the extent of damage which must be valued by some established norm of valuation for repair or reconstructions. Household articles include such things as clothes, furnitures, domestic appliances, water pumps, means of transports, books etc. If percentages can be worked out for damages of household articles then the assessment may become simpler. Damage to stored goods - professional tools and equipments etc. can be similarly estimated.

Row 9 : Loss of Government/local municipal properties : This row should include loss to mining, construction, manufacturing and wholesale, retail and other properties. But loss to industries, agriculture, fishing, transport, communication and other public utilities should be excluded here.

Row 10 : Industrial loss : The industries concerned should be requested to furnish the damages incurred. Indirect damage due to suspension of routine activities may be evaluated by sampling methods. The relevant data in this connection are the number of operational days lost. The number of workers affected, and the value added by industries (per worker per day). However often percentages are assumed for the total loss of general property and industry.

Row 11 : Loss of public work facilities : This includes

1. Agricultural lands
2. Irrigation and Drainage installations
3. Roads and bridges
4. Flood Control installations
5. Harbour, fishing and airport installations
6. Erosion control systems and land slides
7. Streets and roads, urban drainage systems
8. Other public works

All these include all facilities to restore which Government funds would be necessary including restoration of farm lands.

Row 12 : Loss of public utilities : These include inter alia the following facilities

1. State and private railways
2. Other land, air and water transportation systems
3. Telecommunication systems
4. Power generation, transmission and distribution systems
5. Water supply systems
6. Gas supply

These mainly consists of organisations operated by the Central Government, State Government or autonomous agencies. Damages should be estimated in terms of building structures (excluding houses), rolling stocks, ships and boats, plants and machineries, and other capital assets and stocked materials and components, including losses incurred through the suspension in full or in part of operations.

2.272 PREPARATION OF THE FINAL SECOND STAGE CDMA REPORT :

After the Divisional Revenue Officer has collected all the CDMA reports from the various areas ravaged by cyclone, he should prepare an overall report and send it to Secretary Revenue Department for further processing for financial assistance. The precise nature of the financial assistance given to the cyclone victims and related matter is discussed in Section V.E. The Committee recommended :

CRC/217 : After the Divisional Revenue Officer has collected all the CDMAs from the various areas ravaged by the cyclones he should prepare a complete second stage CDMA report and send it to the Secretary, Revenue Department of the State Government for further processing for the request going from the State Government for financial assistance from the Central Government and advising the State Government about expenditures on financial relief to cyclone victims and various expenditures on other heads requested at the various stages of the CDMW.

2.273 THE FINAL REPORT ON THE CYCLONE :

At the end of the cyclone the State Government should prepare a final report on the cyclone. It would be convenient that the Commissioner for Cyclone Rescue Relief and Rehabilitation be given the responsibility to prepare it and submit to the SCYC for record. The SCYC may send copies of this report to the ACC and the IMD for their information. The Committee recommended :

CRC/218 : After the cyclone the Commissioner for Cyclone Rescue Relief and Rehabilitation should prepare a final report on it containing

1. The success/failure of the Cyclone Monitoring System (CMS) as given by the report of the concerned ACWC/ CWC
2. The success/failure of the Cyclone Warning System (CWS)
3. The success/failure of the measures encoded in the Cyclone Emergency Action Plan (CEAP) of the concerned State Government as prepared by the Revenue Department
4. The total assessment of physical/economic damages and loss of life as given by the final report of the Second State Cyclone Damage Assessment (CDMA) prepared by the Secretary of the Revenue Department
5. The total expenditure incurred in carrying through the measures encoded in the CEAP and how the financial problems were resolved as given by the final report of the Secretary of the Revenue Department
6. The success/failure of the Community Preparedness Plan of the State against the cyclone (CPPC)
7. Plans for Rehabilitation/Reconstruction as prepared by the State Government
8. Suggestions of remedial measures for any lacunae and for necessary long term measures.

V.E. FINANCIAL MANAGEMENT OF CYCLONE DISASTERS

2.274 VARIOUS EXPENDITURES NECESSARY DURING A CYCLONE DISASTER :

At all stages of a disaster of even moderate dimensions heavy expenditure have to be incurred by the concerned State Government, most of which are unavoidable as it is not always possible to estimate what has to be faced and much preparations have to be done whether they are justified by the fianl shape of the disaster or not. Broadly speaking it is convenient to classify the expenditures under the following headings :

1. Expenditures at the anticipatory/preparatory level : The State Government must on receipt of the 'Cyclone Alert' signal take a number of preparatory steps all of which are expensive
   (a) Transportation and stock piling of relief materials at strategic centrs : Relief Centres/Cyshels/ Refugee Camps etc. in the AsD and AsGD of the threatened segments of the State. The expenditure

in the second stage - Cyclone concurrent stage, can be much reduced if such stock piling of relief materials are done in advance since later much larger expenditure would be needed to purchase the materials and rush them to the victims in phase 2 & 3 i.e. during 'Cyclone Warning'/Post Cyclone phases. Moreover immediate relief during phases 2 & 3 can not be rendered to the victims unless the relief materials are in hand near to the sites where the victims have clustered and gathered.

(b) Mobilisation of vehicles (land/water) and various equipments for Evacuation/Rescue operations : All these vehicles - buses/lorries/jeeps/powered launches/boats/country boats have to be stationed at strategic points and enough stock of fuels for driving them built up and distributed into the threatened areas so that these are readily available when the vehicles would be required to be put into use. The rescue equipments also have to be collected from the Cyclone Stores and moved to where the evacuation/rescue vehicles have been stationed.

(c) Machineries/materials for repairs/setting up of roads/bridges/railway station buildings/buildings/housing/refugee camps/cyclone shelters. All these must be gathered and distributed to strategic points so that they are available when required.

(d) Machineries for clearing debris and fallen trees

(e) Portable water pumps for pumping water from inundated areas

(f) Deployment of highly trained personnel : To be able to manage a disaster of the magnitude of a severe cyclone officials of the State Government highly trained in disaster management have to be deployed in various places in the threatened areas with given tasks/responsibilities and they should be on duty for a considerable period even after the cyclone. The matter of training these officials is discussed in paragraph 2.309.

(g) Bunds repair/Breach filling machines : As there is always a danger of the water reservoirs - hydrodams/lakes/rivers/water tanks etc. bursting therebanks because of over precipitation of rain water and storm surge all these equipments have to be collected and positioned at places of likely danger.

(h) TC systems : All the TC systems have to be brought upto a full stage of efficiency and mobile

WT/VHF/UHF cars positioned at predetermined points in the threatened areas near the CDMW centres. Fuel for running these cars and spare parts for transmission/reception equipments have to be stocked.

(i) The gathering places for the cyclone victims - Refugee Camps/Cyclone Shelters/Railway Stations : All these places have to be furnished and stocked with various types of equipments necessary for the comfort of the refugees - relief materials, equipments for cooking and canteen facilities, TCCs, medical/epidemic control equipments etc.

2. Concurrent Expenditures : When the cyclone is raging there will be heavy expenditures incurred under the following heads

   (a) Evacuation/Rescue Operations

   (b) Emergency repair of Roads/Bridges/Bunds/Breaches of embankments

   (c) Relief for victims gathering at Refugee Camps/ Cyshels

3. Post Cyclone Expenditures : The expenditures are mainly on the following items :

   (a) Relief/Rehabilitation of the Cyclone victims : In paragraph 2.261 three stages of this kind of expenditure have been mentioned : (1) Immediate relief, (2) Cash relief to individual victim for subsistence and token grants for restoration of normal life and (3) Long term relief for rehabilitation

The quantum and duration of the relief should be commensurate with the magnitude of the distress caused by the cyclone. Different States have different norms for reliefs and are constantly extending the types/scopes of the relief. In paragraph 2.275 the norm followed by the Tamil Nadu Government has been given. The Government of India indicates a ceiling of Rs.200/- per damaged house to be given to its owner irrespective of its size/ value. Evidently the house building assistance is not meant to compensate the loss sustained by the victim. It is rather more of a token of the sympathy of the government. The Committee felt that even such token assistance should have some more realistic/reasonable basis. There is another point to be kept in view in the matter of grants/loans for relief/rehabilitation. The main objective of these assistance is to restore assets damaged by cyclones to its precyclone condition. It is the experience that the structures damaged by cyclones can not stand up to subsequent cyclones when merely restored to pre-cyclone condition. It is worthwhile spending a little more on them to bring in a substantial improvement and make them more cyclone worthy. This matter is discussed in more detail in para 2.299. Such extra expenditures are not allowed at present. As a result these structures become a cause of perpetual drain of funds from the State Government's coffer. The Committee felt a liberalised attitude of the State Government would cause considerable saving in the long run.

(b) Expenditures for Reconstruction : Immediate restoration of Essential Services/Public Utilities/ and restoration of normal life would involve possibly a major share of the expenses.

4. Expenditures required by the Community Preparedness Plan against Cyclone (CPPC) of the State : In Section VI the concept of CPPCs would be discussed in greater detail. A major item in the CPPC involving large scale expenditures are necessary to built the Cyclone Sheltors which are absolutely to provide shelter to cyclone victims. The programmes of the CPPC has to be done over a long period of time in well defined phases. Part of all these expenditures have to be borned by the State Government out of its own resources, whereas for disaster exceeding a certain severity in terms of loss of life/property a lion's share has to be borne by the Central Government. Agencies have to be created to provide loans for rehabilitation of the victims, but here again if the loss is very severe or the disaster is repeated frequently, some more drastic measures are needed to help the victims. It is a difficult problem to apportion the shares of the concerned coastal state and the Central Government in the total expenditure, which are generally very high as the number of victims involved are very large and the loss of properties and damages can run into hundreds of crores of rupees in a single disaster. The Committee recommended :

CRC/219 : In general the expenditures for applying the CEAP in a coastal State during a cyclone would be very heavy. As the expenditures have to be met by both the State Government and the Central Government it is necessary that adequate provisions are made by them in their financial outlays for the necessary funds. High priority should be given by both Governments to expenditures on this account.

2.275 QUANTUM OF SUBSISTENCE/TOKEN RELIEFS TO VICTIMS OF NATURAL CALAMITIES* :

The following reliefs are given to victims of natural calamity in Tamilnadu. It is expected that similar reliefs are also available in other States.

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* Anti-disaster Plan - Tamilnadu : Government of Tamilnadu 1978

1. A free cash grant not exceeding Rs.100 each for owners of houses fully damaged by fire, flood or cyclone etc. and Rs.50 each for owners of houses partly damaged and Rs.20 for tenants for clothing only.

2. Loans upto a maximum of Rs.2000 for agriculturists owning lands subject to adequate security as specified and upto a maximum Rs.250 for each poor family for agriculturists not owning lands subject to conditions laid down.

3. Grant of loans for seeds and manure.

4. Grant of remission of land revenue in accordance with the principles laid down in the Standing orders of the Board of Revenue.

5. Postponment of collection of loan instalments with the previous sanction of the Government.

6. Any or all reliefs on a scale in excess of these laid down, can be granted only with the prior approval of the Government.

During 1977 Andhra Pradesh Cyclone the victims were given the following reliefs :

1. Supply of two sets of clothing each consisting of one dhoti/sari costing Rs.30 to all who suffered damage to their houses and belongings.

2. Cash grant of Rs.1000 from Chief Minister's Public Relief Fund to indigent families in which one or more bread winners have died.

3. Supply of seed free of cost to small farmers and tenants for raising Thaladi crop.

4. Payment of subsidy of 25% on fertilisers used for Thaladi crop and a subsidy of 25% of the cost of nitrogen fertilisers used for top dressing Samba crop to small farmers and tenants in the affected areas subject to a ceiling of Rs.20/acre.

5. A price subsidy of 25% or plant protection channels.

6. Supply of coconut seedling free of cost to small farmers.

7. Reclamation of sand cast lands and wells at Government cost in the case of small farmers and for others with a subsidy of 50% of the cost of reclamation inclusive of existing subsidy of 25% wherever it is advisable under the Soil Conservation Plan.

8. Grant of Rs.100/acre to small farmers and tenants in respect to lands under banana or sugarcane suffering damage.

9. Payment of subsidy of Rs.500/acre to small farmers and tenants for restarting the betel vines either partially damaged or totally lost.

10. Assistance by way of grant/loan to various categories of artisans/weavers under the purview of the Tamilnadu Khadi and Village Industry Board.

Usually the distribution of this relief is done through the Gram Panchayats. The Committee felt that all these reliefs need reconsideration from the Government of India because part of the damages and losses like damage due to salinity of land caused by inundation are a result of failures of the Community Preparedness Plan against cyclones. Restoration of houses/buildings/structures need careful study because thoughtless reconstruction would result again in the same damages during subsequent cyclones. It is not possible for an individual to repeatedly take loans to build his residence. On the other hand if a little R&D is done by the Building Research Institutes new concepts of house building in the CPARs may arise saving the residents lot of financial loss though they may have to invest a little more initially. In other areas land zoning laws may be applied to discourage building houses and the victims may be persuaded to go to alternative sites which are better from the point of view of cyclone hazard. But this may be difficult as there is natural attachment to ancestral homes and places of residence and work. The Committee recommended :

CRC/220 : The quantum of immediate subsistence financial assistance to cyclone victims should be reconsidered by the Government of India for upward revision to enable them to survive with dignity.

CRC/221 : The losses incurred by the cyclone victims should be classified under three heads. Under the first head should come those items for which the victims must make good the loss himself : his personal movable properties/professional tools etc. The State Government may help him in this by giving loans on easy terms of repayment. Under the second head comes those losses which are the fruits of his labour or meant for trade like agricultural products, goods for commerce etc. Much of this can be brought under an appropriate Insurance System. Under the third heading comes such items as restoration of residences, restoration of agricultural fields etc. For the technology of restoration R&D may be necessary and the results should be incorporated in the Community Preparedness Plan against cyclone (CPPC). The State should undertake these reconstructions and the relocation of sites as a part of the CPFC as the expenses involved may be too much for individual victims.

2.276 ROLE OF INSURANCE COMPANIES IN CYCLONE DISTRESS MITIGATIONS :

Insurance Companies can play a vital role in cyclone distress mitigation by extending insurance coverage over goods and products in the cyclone prone areas particularly in the areas notorious for being AsD and AsGD. This relieves the concerned State Government of some of the responsibilities of granting relief to cyclone victims. The Committee recommended :

CRC/222 : The Government of India should encourage the Insurance Companies to cover the areas notorious for being areas of Danger and Great Danager and issue suitable directives to them so that on payment of low premium rates, crops, lands, agricultural tools, live stock : milch/drought animals and poultry/ piggery, dwelling houses, tools and produces of small artisans and small scale industries, fishing equipments of fishermen, goods of small trading and business establishments and even human lives can come under insurance protection. Special arrangements should be made for assessment of damage and quick payments of the insured sums after a disaster.

2.277 SOURCES OF FUNDS FOR CDMW :

The question how to provide the funds for meeting all the expenditures in a typical cyclonic situation was brought into high relief after the 1977 Andhra Pradesh Cyclone. The CS discussed this problem and reviewed the modus operandi for such financial assistance. At that time the Centre did not extend any assistance to the States of a non-Plan nature for relief/rehabilitation which was supposed to be covered by the Margin Money alloted annually to the States from the financial resources of the Centre. For natural calamities the States were given Advance Plan Assistance for undertaking these Plan schemes in the affected areas to prevent or to mitigate the distresses caused by such calamities and for other purposes not directly concerned with disasters. The CS realised that such a scheme of assistance were just not adequate for a number of disasters that had occured. The Central Government therefore extended for the first time after the Sixth Finance Commission's Report, gratuitous reliefs in food grains in these affected areas. It was soon realised that even free food grains did very little to rehabilitate a population whose land/dwelling houses/plantations/crops etc. were almost totally devastated by storms/rains/storm surges. It was also found that the cost of the necessary distress mitigation measures was beyond the resource capabilities of the affected States. An argument was forwarded before a Central Team visiting Andhra Pradesh after the 1977 cyclone that the Central Assistance in the form of Advance Plan Assistance against Plan schemes or Ways and Means Advance for undertaking non-Plan relief schemes could only affect very adversely the normal economic and development plans for the concerned State as all these advances are required to be adjusted against the State's Plan or non-Plan allocations in future. It was also mentioned that the State's financial resources alone can not mitigate the distress and rehabilitate the victims and unless it is supplemented by a massive flow of institutional finances through commercial and cooperative banks. New directives were required to be issued to these organisations which do not normally cater to the needs of nearly pauperised populations. The CS sent its view to the Seventh Financial Commission which was reviewing the entire question of Central assistance to States for natural calamities.

2.278 NATIONAL CALAMITY FUND (NCF) :

The CS noted the suggestion from some quarters e.g. from the CDMC for Orissa that when the calamity descending on a particular State is declared as a National Calamity, the Central Government need not confine its assistance to the concerned State to advancing funds to be adjusted later nor should there be too much dependences on the charities of individuals and organisations in India and abroad. The Centre should set up a National Calamit Fund by imposing levies and it should release liberally the required subsidy and loans out of this fund to the affected population and its State Government. The Seventh Financial Commission did not accept the proposal. This Committee however endorsed and reiterated this view :

CRC/223 : The Government of India should set up a National Calamity Fund (NCF) by imposing levies. As soon as possible after the disaster the cyclone affected State Government should make an assessment of the funds it would need for immediate relief and rehabilitation of the cyclone victims and make a request to the Government of India for liberal release of money from the NCF so that it can make the segment of the required subsidy and loans to the affected population.

2.279 PRESENT MODUS OPERANDI FOR CENTRAL ASSISTANCE TO STATES FOR MEETING DISASTERS AS RECOMMENDED BY THE SEVENTH FINANCE COMMISSION* :

The Seventh Finance Commission reviewed the policy and arrangements in regard to the financing of relief/rehabilitation expenditure by the States affected by natural calamities and suggested certain modifications which are contained in Chapter 4 of its report. The Government of India accepted these recommendations which have become effective from 1st April, 1979. The recommendations are briefly as follows :

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* Information provided by Shri K.S Chandrasekeran IAS Special Relief Commissioner, Orissa.

1. Margin Money :

   (a) The Commission recommended much larger amounts of Margin Money than those recommended by the Sixth Finance Commission. It hoped that this would enable the States to bear the burden of relief expenditures even for calamities of more than moderate severity. The States should provide these amounts in their budgets and invest the unspent amounts in easily encashable securities so that these funds are promptly available at the time of need.

   (b) It was recommended that the States provide for the prescribed Margin Money in their budgets every year, the unspent amounts being invested in the manner recommended under (1) above.

2. Expenditure for drought relief : For droughts, if the relief expenditure exceeds the Margin Money the concerned State may supplement the funds from the Plan allocations for relief employment to the maximum extent of 5% of the annual Plan outlay. A Central team in consultation with the State Government would assess the quantum of funds which has to be so diverted from the Plan and its recommendations have to be approved by the Government of India. This Plan contribution should be treated as an addition to the Plan outlay for that year and covered by Advance Plan Assistance according to arrangements in force in 1974-1979. The adjustment of the Advance Plan Assistance against ceilings of Central Plan Assistance should be completed within five years. If the funds recommended by the Central Team and High Level Committee can not be adequately met within a particular limit after the State Government makes the contibutions in the manner specified above, the extra expenditure should be met by the Central Government in the form : 50% grant and 50% loan.

3. Expenditure for other type of reliefs - Cyclone/Flood reliefs etc. : For calamities of the nature of cyclones, floods etc. the procedure recommended is more relaxed. In regard to the expenditure for relief, repairs and restorations of public works damaged by such calamities, Central Assistance should be available as non-Plan grant, not adjustible against the Plan of the concerned State or against Central Assistance for the State Plan, to the extent of 75% of the total expenditure in excess of the Margin Money.

4. Central Assessment Team for disasters of more than normal severity : In the event of a State being hit

by a natural calamity of more than normal severity necessiating relief expenditures in excess of the accumulated amounts of the Margin Money the concerned State Government should approach the Ministry of Agriculture and Irrigation - Department of Agriculture, for a depuation of a Central Team to make an on the spot assessment of the damage caused and requirements of additional expenditure by the State and to recommend the ceilings of additional Plan and non-Plan expenditures itemwise. To help the Central Team and the State Government should prepare a comprehensive memorandum containing all relevant details which must be prepared in accordance with the guidelines issued by the Ministry of Agriculture and Irrigation in this regard.

5. Extension of Central Aid for calamities of rare severity : When the calamity is of rare severity, the Central Government may find it necessary to extend its assistance even beyond the normal limits specified above.

6. Caution about relief/rehabilitation expenditures : Since the affected State will ultimately have to bear a sizeable part of relief expenditures, it is necessary for the Central Team and other High Level Committees not to take a too relaxed a view of the expenditures needs so as to avoid expenditures of doubtless value which needlessly add to the burdens of the State.

7. Norms to be observed about relief/rehabilitation expenditures : It is necessary to ensure strict compliance with the various observations and recommendations of the Public Accounts Committee regarding the norms to be observed in incurring expenditures on relief of distress caused by natural calamities.

8. Accountability regarding relief/rehabilitation expenditures : It is of paramount interest that the accounts of expenditure on various Plan and non-Plan items are maintained properly by the State so that no difficulty is experienced by the audit authorities in furnishing the audited figures of expenditures and the figures are readily available to the Central Teams deputed to monitor the required expenditures.

2.280 NEED FOR RECONSIDERATION OF THE RECOMMENDATIONS OF THE SEVENTH FINANCE COMMISSION FOR DISASTER PRONE STATES :

The Committee noted :

1. Though it is well understood that the Seventh Finance Commission has adopted a more liberal approach compared to the earlier Commissions with regard to the questions of allocation of the Margin Money and sharing of expenditure relating to cyclones so far as the relief/

rehabilitation/restoration measures are concerned i.e. with the Second & Third phases : Concurrent and Post Cyclone phases, it does not seem to have given consideration to the financial burdens imposed on the State by First phase expenditures : Anticipatory/Preparatory expenditures and the long term measures : expenditures according to the CPPC of the State. The expenditures on the First phase and for the CPPC are not allowed out of the Margin Money or from the Plan/Non Plan Central Assistance.

2. All the States has been treated on the same footing and the Commission has given no special allowance to the States which are frequently visited by cyclones and which have negligible revenue surplus and are economically backward. When a major natural calamity strikes such a State requiring a large outlay, it would be required to find substantial funds to meet their share (25%) of the expenditure. As an example the case of Orissa which was affected by a very major flood recently, might be cited. The Government of India indicated a ceiling of Rs.162.89 crores for distress mitigation expenditures, so that the State Government has to find about Rs.40.72 crores which was very large indeed. If the concerned State Government is forced to divert its resources meant for Plan schemes, the net effect would be an overall slowing down of the progress of the Plan schemes not only in the year of the disaster but also for many subsequent years. It appeared that the main mobilisation of the Seventh Finance Commission for not recommending 100% Central aids in such situations was the fear that this would result in inflation of the expenditure beyond reasonable limits and prove to be a big drain on the Central Exchequer. In paragraph 2.281 the Committee has suggested some changes in the damage assessment by the Disaster Reconnaissance Team (DRT). If this suggestion is followed then the danger of exaggeration of the losses may be reduced. In that 100% Central aid should be granted to the affected State.

3. The Seventh Finance Commission has made no recommendation for the minimum scales in respect of different items of relief e.g. quantity of food grains to be given in phase 3 - Post Cyclone Phase, duration of such relief, assistance to house building etc. so as to ensure uniformity and provide atleast the absolute minimum subsistence/rehabilitation requirement. The Committee recommended :

CRC/224 : The Government of India should have a scale measuring the severity of a disaster in terms of loss of life/ property. Beyond a certain level in the scale (mild disaster), the State Government should be able to meet all the expenditures : Anticipatory/Preparatory, Concurrent, Post disaster, from its own resources. Above this level and below another when the disaster can be termed severe, the present recommendations of the Seventh Finance Commission for Central Assistance should apply unchanged i.e. the shares of the costs would be Central Government 75%, State Government 25%. If the disaster is more severe the Central Government should bear 100% of the costs which would also include restoration/reinforcement of the facilities/preventives created by the State Government under its Community Preparedness Plan (CPPC).

2.281 LACUNAE IN THE PRESENT SYSTEM OF ASSESSMENT OF DAMAGES :

At present the Revenue Departments of the affected State Governments prepare a memorandum containing its own assessment of the damages caused by the disaster. This is usually accomplished with very great speed as funds are urgently required in phase 3 viz. the Post Cyclone period for relief/rehabilitation/reconstruction measures. More often than not for various reasons the requirements of funds put down in this memorandum tend to over exaggerate the losses incurred in the disaster. The Central Team, usually from the Agriculture Ministry of the Government of India visits the affected state and spends two to three days in visiting a few typical places of disaster and in holding discussions. This arrangement does not allow a proper objective assessment of the damages and losses. Moreover in trying to undermine a possible inflation of requests for funds by the affected State, the Central Team very often goes to the opposite extreme of taking on adhoc and arbitrary view of the fund requirements. Not only does this confrontation often has political undertones, but it has a very unfortunate effect on the assets of the affected State which are often damaged by the disasters but can not be repaired/restored due to lack of funds, because the minimum requirements may be rejected. In States which are prone to natural calamities, public utilities progressively deteriorate and the States suffer economic set backs from which they can not recover. Infact many of the Cyclone prone States have not adequate funds even for normal maintenance of these utilities/services and are in no position to meet the gap in requirement of funds for their repair/restoration. The Committee recommended the following procedure for immediate financial assistance by the Central Government to the affected State.

CRC/225 : Immediately after the occurance of a natural calamity like Cyclone, the Government of India can release some funds on an adhoc basis after receiving the report of its Disaster Reconnaissance Team (DRT) visiting the affected State. With this assistance immediate relief to individual victims and restoration activities can be taken up.

CRC/226 : The Disaster Reconnaissance Team (DRT) of the Central Government should consist of technical officers inter alia from the following Ministries/Departments of the Central Government.

1. AIR

2. Central Water Commission
3. Central Power Commission
4. Central PWD
5. Post and Telegraph
6. Public Health
7. Public Health Engineering
8. Road and Transport Department
9. Ministry of Agriculture
10. Ministry of Finance
11. Ministry of Inland waterways
12. Ministry of Shipping.

CRC/227 : The DRT should visit the affected State immediately after invitation by its Chief Secretary. It should then have a series of meetings with the SCYC and discuss the Final Report of Damages caused by the cyclone as prepared by the Revenue Department of the Seate and make its own assessments by on spot inspections and interviews with samples of groups of victims in the AsD and AsGD. This will give the team an objective view of the disaster.

CRC/228 : The final meeting of the DRT and the SCYC would consider the question of the ceiling of the legitimate Central Assistances to the affected State and also the quanta of fund allocations under different heads.

CRC/229 : The DRT should submit to the Government of India its final report of the damages caused by the cyclone within three-four weeks after the 'Cyclone Dewarning' signal.

CRC/230 : Though the progress of discussion between the DRT and the SCYC outlined in recommendations CRC/225-229, it is expected that the fears of the Central Government that the damages caused by the disaster have been over exagerrated, would be dispelled. The report of the DRT would assist the Government of India to establish the scale of the disaster and take decision on the quantum of financial assistance which can be given to the concerned State Government.

2.282 DIRECTIVES AND GUIDELINES FOR RELIEF MEASURES BY BANKS IN AREAS AFFECTED BY NATURAL CALAMITY* :

The State Government is not the only source of relief for the victims of natural disasters. Extensive and elaborate directives and guide lines have been issued to the Commercial and Cooperative Credit Institutions for liberal sanctions to cyclone victims. A set of these guide lines are presented in appendix 2.16 paragraph 2.367. It will be seen that the only facility offered to the victims is that the short term loans taken by them is converted into medium term loans and a rescheduling of payments of the instalments in respect to the medium term loans in areas where the crop loss is more than 50% due to natural calamities when a declaration to this effect is given by the Collector. The credit problems are not adequately met by the guidelines to the Banks. A large number of victims come under the category of defaulters in respect to previous loans. The facility of conversion does not apply to such defaulters. The eligibility of Cooperative Banks to get refinance facilities in respect of medium and long term finance depends on the percentage of recovery of loans is naturally below the prescribed percentage. The Commercial Banks do not act strictly according to the guide lines.

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* Information provided by Shri K.S. Chandrasekeran IAS Special Relief Commissioner for Orissa.

2.283 RELIEF ORGANISATIONS IN OTHER COUNTRIES FOR NATURAL CALAMITIES* :

In some countries like USA and Japan there are organisations and financial systems which help the victims of natural calamities to rehabilitate themselves. Thus the Farmer's Home Administration (FHA) in USA operates emergency loan schemes in the shape of long term loans with low rates of interest and provide technical help to farmers to restore their normal agricultural activities. FHA also provides assistance to reconstruct damaged houses, in acquiring cattles/implements/tools/farm inputs and other requirements for production. Loan for reclamation of land affected by disasters are also provided. In Japan the Finance Corporation for Agriculture, Forestry and Fisheries provide long term loans on easy terms to farmers affected by national disasters. The Committee recommended :

CRC/231 : A National Finance Corporation for Natural Calamity (NFCNC) to mitigate disasters may be set up by the Government of India to provide long term loans on easy terms and provide technical help to victims of cyclones and other natural disasters for reconstruction and rehabilitation for resuming their normal activities, reconstructing damaged houses, acquiring various inputs for productions and reclaiming lands affected by disaster.

VI. SUGGESTIONS FOR A COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONE (CPPC) THREATS AND HAZARDS FOR COASTAL COMMUNITIES IN INDIA

VI.A. THE COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONES (CPPC)

2.284 NEED FOR A CPPC :

Merely having a Cyclone Code or a CEAP is not enough for CDMW. The concerned State Governments have important responsibilities to prepare the coastal communities for cyclones and its hazards. The long and short range perspectives of the measures to be taken for preparing the community to face cyclones have many common features with those required with respect to other possible disasters. It seems that unfortunately this aspect of preparing the community against such hazards has been largely neglected by the coastal states. Their interests are raised only when the disaster has happened. Many of the measures if taken in time could reduce the loss of life/ property caused by cyclones and confine them within manageable limits. The Committee noted that during the Andhra Pradesh Cyclone of 1977 the State Government officials felt helpless and had the impression that it was impossible to evacuate lakhs of people and that there was no shelters where they could be shifted. For subsequent cyclones it was much better prepared. The Committee recommended :

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* Working Paper No.5 placed before the Committee by IMD.

CRC/232 : The coastal states containing CPARs should include in their Disaster Plans, short and long range measures to prepare the resident communities to face the threats and hazards of cyclones. All these measures should be incorporated into a Community Preparedness Plan against Cyclones (CPPC) for the State.

2.286 CPPCs IN OTHER COUNTRIES* :

Australia, Japan and USA have highly developed systems for disaster prevention and preparedness against cyclonic invasions of the coasts. Long term measures such as flood control, land use control, zoning and building codes have been developed. Constant scrutiny is maintained over short and long term stategies for disaster prevention and preparedness. Economic Social Commission for Asia and Pacific (ESCAP), WMO, and league of Red Cross Society (LRCS) have prepared guidelines for disaster prevention/preparedness against cyclones. The guidelines are the result of experience of concerted actions in these directions in many countries. The main features of the guidelines are :

1. Legislation for disaster prevention : Both day to day activities and long term activities of the Governments are guided by legislation which gives executive authority/responsibility to various Government Departments and other agencies for taking appropriate actions. For following measures legislation is needed.

   (a) The preparation of risk microzoning maps for all hazards

   (b) Land use/zoning laws to restrict/prevent industrial and/or residential development in areas where risk potential is high e.g. flood plains/

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* Working Paper Nos.5, 27, 28 put before the Committee by the IMD.

low lying coastal areas vulnerable to storm surges

(c) Building codes setting our minimum safety standards in the CPARs

(d) Soil/plant conservation measures to minimise erosions

(e) Engineering measures relating to management/control of rivers/canals/other areas vulnerable to flooding by storm surge

(f) Public health measures concerned with sanitation (air/water/waste disposal) and related matters

2. Risk evaluation : An important step is to assess the vulnerability of different part of the country to cyclone as that would form the basis for planning/implementation of measures for disaster distress mitigation. The historical data on cyclones visiting different parts of the country would be an important guide line in risk evaluation for these parts. The hazards due to winds/floods/storm surges should also be estimated similarly for various parts of the country.

3. Land use/zoning : It appears that legislation with respect to land use control measures with respect to disaster does not exist. Based on risk mapping/risk microzoning of the CPARs, land use legislation/regulation measures require to be promulgated. Some of these measures are

   (a) Legal measures for the enforcement of zoning and other regulations for controlling the type of activity and the density/pace of development

   (b) Taxation measures to steer development away from areas of hazard

   (c) Government actions to acquire land by compulsory purchase and to alter land use

   Land development/use/management should be decided on the basis of risk evaluation.

4. Building codes : Suitable building codes in CPARs need to be developed

Suggestion for a CPPC made in this Section are based closely on these necessities.

2.286 THE OBJECTIVES OF A CPPC FOR A COASTAL STATE :

The primary objectives of a CPPC were discussed. The Committee recommended :

CRC/233 : The Community Preparedness Measures against cyclones are for the benefit of the individual, the family, various sections of the population residing in the CPARs of the coastal States engaged in diverse economic activities - agriculture, fishing, trades and industries etc., and various agencies of the Central and State Governments and those of private nature operating in these areas of the State - Defence, Post & Telegraph, Railways, Shipping etc. The primary basic objectives of these measures are :

1. To reduce the risk potential of cyclone damages in the CPARs of the coastal State
2. To educate the coastal community to respond to cyclones in a disciplined manner
3. To train the State Atministrative officials to take control of the situation by applying the CEAP of the concerned State swiftly without hesitation.

2.287 SHORT AND LONG TERM ASPECTS OF THE CPPC :

The Committee recommended :

CRC/234 : The long term aspect of the CPPC concerns with

1. Installation of public utilities/facilities/organisations which help to protect the community against cyclones and providing of an infrastructure for their maintenance
2. Spreading the awareness of the hazards of cyclones among the public and educating them about the ways and means of meeting them
3. Training the workers for CDMW

The short term aspect of the CPPC is

1. To inspect all the public utilities/facilities/organisations at the beginning of the cyclone seasons every year to ensure that these are in a fit and proper condition to be used efficiently during a cyclone emergency. Any lacunae detected in these systems should be promptly remedied by the appropriate Department of the State/Central Government or the Coastal Development Authority.

2. To supervise and coordinate all repairs/reconstruction work after every cyclone disaster.

The actual work may be done by various Departments of the State/ Central Government and various agencies as suggested in Section V.B paragraphs 2.197-2.200.

2.288 FUNDS FOR COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONES (CPPC) FOR A COASTAL STATE :

The concept of a CPPC for a coastal state has been discussed. Broadly the CPPC covers a large area of endeavour for creating permanent utilities/facilities in the State together with supporting organisations which shall be useful during a cyclone regime in preventing losses to life/property. The work would spread over a long period of time and involve large expenditures. The proper way of handling these works is to mark them out as Plan Schemes for the State and provide budgetary outlays for the programmes in its 5 Year Plan. The Committee recommended :

CRC/235 : Implementation of the measures suggested in the Community Preparedness Plan against Cyclones and the maintenance of the various public utilities/installations set up in the State for it would need large outlay of funds. The State Government should provide for these outlays in their 5 Year Plan Provisions as Plan Schemes and in their annual budgets to carry the schemes through.

VI.B COASTAL DEVELOPMENT AUTHORITY (CDA)

2.289 NEED FOR A COASTAL DEVELOPMENT AUTHORITY (CDA) IN COASTAL STATES :

Many of the problems faced with CDMW are in the nature of coastal development/management. It would therefore be convenient that these be handled by a Coastal Development Authority (CDA) set up by the Coastal State Government. The Committee noted and supported the suggestion of the Tamil Nadu Government to the Committee of Secretaries which was for the constitution of a high power technical committee for preparing a programme of coastal management associating with it organisations like the IMD, the Indian Navy etc. and officers of the Central/State Government. The Committee however felt that this Committee should have sanctioning and executive powers also to be able to implement properly its coastal plan. The Committee recommended :

CRC/236 : Each coastal State should have its Coastal Development Authority (CDA) to prepare short and long range plans for development of the coastal areas in the State. Measures for reducing the dangers from cyclones for the community should form important part of the task assigned to this body.

2.290 COMPOSITION OF THE CDAs :

The Committee made the following suggestion for the composition of the management committee of the CMAs.

CRC/237 : The management committee of the CDA may have the following composition :

Chairman : To be appointed by the State Government

Members : Members to be nominated one from each of the following Ministries/Departments/ Commissions/Authorities of the State/ Central Governments.

A. State Government

1. Agriculture & Community Development Department
2. Education Department
3. Finance Department
4. Forest Department
5. Irrigation & Waterways Department
6. Panchayat Department
7. Planning Department
8. Police Department
9. Public Works Department
10. Public Health Engineering Department
11. Revenue Department
12. Roads and Transport Department
13. State Electricity Board

B. Central Government

1. Agriculture Department
2. AIR
3. CPWD
4. Central Water Commission
5. Department of Environment
6. IMD - NHAC (Delhi)
7. Department of Ocean Development
8. Inland Waterways Authority
9. Land Development Department
10. Ministry of Law - Legislative Department
11. P&T Department
12. Railways
13. Roads and Transport Department
14. Rural Development Department
15. Shipping Ministry

2.291 TERMS OF REFERENCE FOR THE CDAs :

Among the various tasks and responsibilities of the CDAs the Committee felt that the following should be emphasised for preparing the community against cyclones :

CRC/238 : Among the various tasks and responsibilities of the CDA of the coastal State the following would be relevant for the purpose of preparing the community for cyclones

1. To establish close contacts with the SCYC for getting acquainted with the problems faced and the experience gained regarding the ravages of each cyclone landfalling in the State and to draw up long range plans for preparing the community against them after detailed risk evaluation by joint consultations.

2. To keep contacts with the ACC for consultation about the preparation of the CPPC of the coastal State.

3. To demarcate areas on the coastal strips where land zoning laws have to be enforced by it.

4. To demarcate areas on the coastal strips for which protection against storm surges may be possible by construction of bunds and be responsible for their constructions and maintenance.

5. To establish forest belts on the coastal strips for protection against cyclones and prevention of soil erosions caused by them.

6. To make arrangements for periodic dredging of rivers in the CPARs of the coastal State.

7. To formulate and implement plans for long term soil and plant conservation in the CPARs.

8. To plan and implement an efficient drainage system in the CPARs to remove the standing flood water.

9. To establish a close network of roads and bridges in the CPARs.

10. To formulate and implement plans for protection of agricultural products against cyclones and storm surges in the CPARs.

11. To lay down a set of building codes in the CPARs and to act as consultants in this matter for private owners of house properties. The CDA should enforce the Building Codes for all buildings in the CPARs.

12. To establish permanent cyclone shelters in the CPARs.

13. To plan, instal and maintain an efficient sewerage system in the CPARs.

14. To establish community hospitals at strategic points in the CPARs.

15. To introduce measures for protection of fishermen at sea.

16. To liase with the P&T Department for installation of a snap proof TC system in the CPARs

17. To prepare a detailed map of facilities/public utilities/installations in the CPARs of the coastal State available for CDMW showing.

    (a) Location of the forecasting centres : ACWC/CWC, FFOs of CWCM/State Irrigation Department/IMD

    (b) Locations of various departments of State/Central Government and various agencies involved in CDMW.

    (c) Agricultural lands

    (d) Location of villages/towns

    (e) Beaches

    (f) Forest belts

    (g) The TC network

    (h) The road/bridge network

    (i) The waterways network

    (j) The irrigation heads/hydrodams/lakes/water reservoirs and bunds/embankments/dykes for flood control, dredging points for rivers

    (k) Areas prone to inundation

    (l) The drainage system/location of drainage pumps - actual/possible sites

    (m) Cyclone shelters/possible sites for Refugee Camps

    (n) Public hospitals, medical centres

    (o) Stores of various types for disaster fighting

    (p) Sewerage network

    (q) Location of electric power houses and the electricity distribution network.

(r) Tracks of Railways running through the CPARs together with the Stations

(s) Location of shipping ports of various types, fishing ports, fishing villages

18. To prepare Cyclone hazard potential maps showing

(a) Possible breakdown locations of TCCs and alternative channels

(b) Possible areas of submergence under storm surges of a given height travelling in a given direction for a given landfall point

(c) Possible areas of submergence under a given amount/duration of rainfall

(d) Possible direction of water flow after dam burst/breach of embankment etc.

(e) Possible areas where evacuations are generally necessary

(f) Possible locations of breakdown of road communications.

VI.C HIGHLIGHTS OF A CPPC

2.292 Zoning Laws for Land Use :

CRC/2); The Committee had recommended earlier (Recommendation that the ACC should advise the Central Government about land use and zoning laws to prevent industrial/housing development in the CPARs and in Recommendation CRC/238 has further recommended that the CDA should enforce such laws. In addition on the item of land use in the CPARs the Committee recommended :

CRC/239 : The concerned CDA should examine the topology maps of the coastal strips in its state which were classified as CPARs in Recommendation CRC/6 and demarcate zones where housing/industrial constructions have to be discouraged and controls have to be imposed on the construction of buildings and the pace and type of development activities. Also areas where raising of normal agricultural crops are hazardous should also be marked out. Such areas should be made known to the public with warnings tnat they come under land use and zoning laws which would be strictly enforced if it becomes necessary.

CRC/240 : The State Governments through their CDAs should enforce punitive measures against violaters of land use and zoning laws in the inundated areas in the CPARs such as imposing fines and penalties, demolition measures, high taxation measures etc. If necessary the State Government may acquire by legislation such lands through compulsory sales.

CRC/241 : The great success of the traditional dykes and seawalls in Netherlands should be studied by the CDAs to consider whether similar measures could be introduced in India on an experimental basis on selected sites to save coastal land from the onslaught of storm surges from the sea and prevent the growth of salinity in them.

CRC/242 : The Department of Environment and the Department of Forestry of the Central Government may be consulted by the CDAs for the formulation and implementation of an aforestation programme in selected coastal areas on an experimental basis with the objective inter alia of breaking the fury of the cyclone winds and storm surges.

CRC/243 : The Department of Environment of the Central Government may be consulted by the CDAs for formulating the long term measures that should be introduced for soil and plant conservation and to prevent large scale coastal erosions that become inevitable under the action of cyclones and storm surges.

2.293 MODEL STUDIES OF INUNDATION POTENTIALS AT THE CPARs :

The Committee has already recommended (Recommendation CRC/6), that the coastal State Governments should prepare topological maps with contour lines at 1m interval of the CPARs. The Committee however felt that this was not enough to predict the spatial extent and the depths of inundations of these areas when the storm surge comes in, which should be shown in maps prepared by the CDAs (Recommendation CRC/238). The Committee recommended :

CRC/244 : Maps should be prepared by the State Irrigation Departments of the coastal states in consultation of the IMD and River Research Organisations in the State, showing various possibilities of the spatial extents and depths of inundations in particular locations for a given direction of entry of a storm surge, intensity of rainfall, extent of standing water, condition of flooding of nearby rivers and level of water in the hydrodams in the vicinity, local topology and other similar parameters. Model studies can be made by the various River Research Institutes in the State and also at the Central Water and Power Research Stations at Pune for specific areas notable for frequent cyclone landfalls storm surges and the results of such model studies should be stored in the computers of the ACWC/CWC and the FFOs in the State for ready access/visual display for use as bases for forecasting.

2.294 MEASURES TO REDUCE THE RISK TO LIFE/PROPERTY IN FLOOD/ STORM SURGE SITUATIONS :

Various aspects of storm surges and the consequent dangers have been discussed in many places in this report.

Certain other aspects of storm surges may be considered in this paragraph. During a cyclone regime it ofter happens that the river dams have so much water held by them that it becomes imperative to release considerable amounts of water to prevent dam bursts. This as already mentioned (paragraph 2.18) adds to the intensity of the flood threats in a cyclone regime. The Committee recommended :

CRC/245 : The CDA should consult the Flood Forecasting Centres of the Central Water Commission/State Government/IMD to map out the path of water from the hydrodams situated near the coastal regions which may have to be released during cyclone regimes to prevent damages to these dams or which may be caused by dam bursts, and also the location/extent of areas which are likely to be inundated as a result.

CRC/246 : The technical officers of the State Irrigation Department should make annual inspection of the flood control facilities before the onset of the monsoon/cyclone seasons and take remedial measures against any failures of these facilities. The inspection should in particular include looking into the state of the flood banks, dykes, embankments hydrodams etc. Since the main danager to life and property in a cyclone situation arises out of storm surges it is necessary to have some investigations on ways and means to reduce the fury of the storm surges right from the point it crosses over the coast. Some of these methods are reviewed in Appendix 2.23 paragraph 2.383. The Committee recommended :

CRC/247 : There should be some research investigations by an appropriate Research Organisation for developing the methods which are best suited to reduce the fury of the incoming storm surges. The CDAs should try out these methods at selected sites on the coast on an experimental basis.

CRC/248 : There exist some methods already which break the fury of storm surges - development of anchored inflated rubber tyres, cement cross pieces (dolosee) vertical piles and other type of obstructions to free flow of water along the beaches of the coast lines. The CDAs should examine the effectiveness of these methods in selected points of the coast generally vulnerable to cyclonic storm surges and in the approaches to selected villages which are repeatedly attacked by cyclones.

2.295 DRAINAGE NETWORK :

During the 1978 West Bengal depression wide areas in that State including the metropolis of Calcutta and its suburbs were under deep waters for a considerable amount of time. This was the result of combination of effects of heavy precipitation caused by the depression and release of water from the hydrodams in the vicinity and failure of the drainage system. The

Committee endorsed the Recommendation of the CDMC (CDMC/27) and extended it for other coastal states also.

CRC/249 : Since the rivers constitute a natural drainage system which should be able to carry away the greater proportion of the flood water, river beds and river mouths should be annually dredged by the Department of Inland Waterways before the onset of the monsoon/cyclone seasons and kept in a trim condition to drain off efficiently the flood/storm surge discharges and over precipitation of rain.

The Committee noted the comments of the Empowered Committee of Secretaries (ECS) regarding the high cost (running into crores of Rupees) of the dredging project for rivers which would by its very nature be of a continuing kind and that suitable dredgers may not be made in the country requiring import of the necessary machines. The Committee also noted the remarks of the representative of the Andhra Pradesh Government about its inability to carry out such expensive projects out of its own resources. In spite of these observations the Committee felt that dredging projects are unavoidable not only because of the spinoff benefits for land and crop protections from ravages of floods but also because of other benefits like maintenance of waterways, prevention of rise of river beds and the consequent damages done to the surrounding environments etc. It is not sufficient to maintain the drainage systems consituted by the rivers in good conditions; it is also necessary to establish a network of water drainage channels in the coastal waters. The Committee recommended :

CRC/250 : The CDAs should plan and establish a network of permanent water drainage channels not only to protect the agricultural fields in the CPARs but also to remove as much of the flood water as possible. These channels should also be maintained by the CDAs in proper condition and should be annually inspected.

CRC/251 : Diesel driven pumps should be installed at strategic points to route the standing water to these drainage channels which would transport it ultimately to the main drainage system constituted by the rivers in the areas or directly to the sea, if that is possible.

2.296 TC NETWORK FOR CPARs :

It may be necessary for the CDA to establish their own TC network for the totality of their activities would certainly cover a very large field and demand a separate communication system. This TC system may be used for cyclone emergency if necessary. The Committee recommended :

CRC/252 : If the CDAs establish their own TC systems, it would be a great help to the DCCs if these channels are made available to them during cyclone emergencies.

In course of time the CDAs with the help of other Departments of the Government of India should build up a cyclone proof TC network for CDME. The Committee recommended :

CRC/253 : The CDAs should plan a cyclone proof TCC network for cyclone reporting and for CDMW, incorporating systems like two way voice transmission WT systems etc. and in course of time build up such a system with the help of the P&T Department and the IMD.

It is important that the Community Radio Sets/TV Receivers are kept in good condition so as to receive clearly the CAs and CWMs. The Committee endorsed the recommendation of the Andhra Pradesh Government*.

CRC/254 : It is the responsibility of the Assistant Engineer, District Public Relation Officer and the Block Development Officer to ensure that the Community Radio Sets/TV receivers are kept in good condition to receive on all occasions the CAs and the CWMS. Specific persons should be appointed to listen to these broadcasts at the village level and disseminate the messages to all villagers. The persons to be nominated will be in the category of Sarpanch/Panchayat clerk/Executive Officer/ Village Development Officers/Headmaster of Elementary School or persons of similar ranks/class.

2.297 COASTAL ROAD/WATERWAYS NETWORK :

Sections of the coastal population threatened by cyclones and storm surges can move to places of shelters or they can be evacuated only if there is a well developed dependable road/ waterway network established for this purpose, which is properly maintained. There is a general view that at least 25 kms of the coastal strips should be covered by such road networks, but the actual width would depend on the geographical nature of the strip. The Committee recommended :

CRC/255 : The CDAs should establish a close network of roads and bridges, connecting the villages and cities within 20-25 km of the coastal strips.

CRC/256 : The CDAs should develop waterways and landing piers for commuting between the coastal islands and the main land and for travelling along the rivers.

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* Cyclone Contingency Action Plan : Revenue Department, Government of Andhra Pradesh Hyderabad 1981.

The Committee noted that ECS had recommended that the necessary funds should be provided by the concerned State Government out of its own resources or through their annual Plan allocations. The Committee also recommended :

CRC/257 : The CDAs should also take the responsibility of maintaining these network of roads and waterways because their proper functioning is a very important part of any coastal management plan.

CRC/258 : The CDAs should improve the quality of the coastal road network in gradual phases starting with kuttcha roads and finally terminating with roads on which lorries and buses can travel.

Regarding Railway tracks, the Committee noted the danger of the tracks being washed away under storm surges. It recommended :

CRC/259 : The Railway Department may consider raising the railway tracks on artificially raised earth humps or bunds in areas where storm surges usually occur frequently.

2.298 EMERGENCY ELECTRICITY :

It may become necessary for avoiding accidents to switch off electric power over large areas of the affected areas during the second phase of a cyclone emergency and to resort to standby diesel generators for supply of power. The Committee recommended :

CRC/260 : The District Collector should have a list of diesel generators located at various cinema halls, and other places which can be requisitioned during cyclone emergencies. He should also keep a list of priorities for moving the diesel generators to various places where emergency power is needed : Refugee Camps/Cyshels/hospitals/CDMW centres etc. Arrangements must be made to mobilise trained personnel at short notice to operate these generators. A rigid watch should be kept on these generators when put into emergency use and they should be returned to their owners without fail when the emergency has passed.

In the third phase of the emergency, electric power has to be restored first on restricted basis to places whose priority for receiving supply is high, and then when the emergency has passed on an unrestricted basis. The list of priority for restoration of electric power has been already given in Recommendation CRC/178. The Committee further recommended :

CRC/261 : The State Electricity Board should set up alternative routes for power supply to places/installations with high priority, which can be used for restoration of electric power when the normal transmission routes have been snapped by the cyclone.

2.299 ESTABLISHMENT OF A BUILDING CODE FOR THE CPARs :

There are special problems regarding the safety of buildings and industrial plants in the CPARs. There has been considerable work done abroad on this subject. In Japan work on earth-proof buildings design has considerably reduced the dangers of collapse of buildings caused by earthquakes. Similarly if some research and development work done on cheap but sturdy cyclone proof housing is carried out in this country, much of the loss of property due to collapse of buildings under the fury of cyclones or their washing away by storm surges can be reduced. In India the question of keeping the costs low for any innovations in making the buildings cyclone proof, is certainly very important. The buildings can be grouped in two classes : (1) residential houses and (2) public and industrial building complexes. The cost considerations for residential houses, much of which are of the kuttcha type in villages, are of greatest importance. The dangers to these houses arise out of high winds which blow away of the tinned/thatched roofs and mud walls and from storm surges which wash away the walls. The effect of cyclone wind on roofs are mainly aerodynamic lifts produced by air flowing at high velocity and are unlike the way tornadoes destroy buildings as a result of negative pressure difference which causes the walls/roofs to explode. Some of these dangers can be minimised by suitable building designs based on sturdy steel tubes frames with special anchoring arrangements to the ground. Such designs make easy restoration of the huts for the poorer section of the population. It has been observed that so far the cyclonic winds are concerned the traditional high inclined roofed huts in Andhra Pradesh, Orissa and West Bengal stand up very well in their fury. With some elementary change of construction practices they may face such hazards even better. Some of the observations on inclined roofs are briefly summarised in appendix 2.17 paragraphs 2.370-1. There should be R&D on low cost water proofing/strengthening of mud walls or replacement of traditional mud walls by walls made of low cost materials which can stand up to fury of storm surges and which keep their shapes and strengths under water. This signifies that such walls may not stop the water from entering the huts but the walls need not be washed away. Brick buildings are much safer with respect to cyclones/storm surges compared to confrontation with respect to tornadoes. Questions of good foundations for such buildings, shapes, roof securement to walls for safety against wind, spurs on wall to reduce fury of storm surges are important matters for R&D by appropriate Building Research Institutes. For Cyclone Shelters

(CYSHEL)* three basic shapes are now being employed : (1) Circular, (2) Octagonal and (3) L-shaped. While a circular design is generally considered to be best suited to safely withstand cyclonic wind pressures particularly when wind directions are likely to change often, the utilisation factor of the floor area is rather low compared to square and rectangular buildings. However if the height and breadth of the buildings facing the cyclone winds are within certain relative proportions, a rectangular shape may be quite safe and better adapted to floor utilisation. The L-shaped buildings evolve out of the basic rectangular units. The added advantage of such buildings is the ease and speed of their constructions with the utilisation of local man power and the possibility of subsequent modular extension. In Andhra Pradesh it is proposed to try out all the three designs : (1) circular with colaboration of the Red Cross Society, (2) Octagonal with the colaboration of the Tatas and (3) L-shaped with the colaborations of the Roads and Buildings Department and other organisations. In Tamilnadu the circular design has been preferred. A model was exhibited in the International Seminar on Human Habitat held in New Delhi in 1978 and was on view in Tourist Fair at Madras. Designs of all the three types of CYSHELs are given in appendix 2.18, paragraph 2.378. The Committee recommended :

CRC/262 : The CDAs should consult experts on rural housing on the appropriate designs for cyclone and storm surge proof mud houses for the poor regarding effective measures to strengthen the existing ones. While designing such houses techniques should be developed to reinforce the traditional high incline roofs of the mud houses in Andhra Pradesh, Orissa and West Bengal which have shown remarkable success in standing upto the furies of cyclones. Cheap chemical treatment of the mud walls should be developed to stand up against the hammoring/erosion produced by floods/storm surges.

CRC/263 : The Building Research Institute of the CSIR should formulate designs for low cost housings and buildings which can stand upto cyclones and storm surges or which if damaged can be easily repaired and made habitable again.

CRC/264 : The people living in one storied pucca buildings in the CPARs should be advised to keep some bricks and mortar handy or atleast enough sand bags to seal up the doors and windows in the ground floor to prevent flood water from entering. If there are upper floors in these pucca buildings it may not be necessary seal up the ground floors and it may in fact be wiser to keep the doors and windows there open and allow free movement of wind and water.

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* Community Cyclone Shelter Construction Programme for Cyclone Prone Coastal Areas of Andhra Pradesh - Revenue Department Government of Andhra Pradesh, 1980.

For public buildings may need similar treatment particularly those that are used as stores and similar purposes. The Committee recommended :

CRC/265 : The public buildings for which the ground floors are used for storing purposes should have arrangements for quick sealing off all points of entry of water at the ground level. Special spurs may be designed on the outside walls of the ground floor to break the violence of the rushing waters. Points of access to these buildings at levels higher than the usual level of storm surges should also be provided.

CRC/266 : The CDAs may consult various consultants in particular with the Indian Standards Institution to evolve building codes for industrial complexes in the CPARs to take care of special problems arising for these during cyclone regimes. One of the most important functions of the CDAs should be its power to enforce the Cyclone Building Codes in the CPARs if necessary. The Committee recommended :

CRC/267 : By Legislative action the CDAs should be given the authority/executive power to enforce the Cyclone Building Code (CBC) in the CPARs of the State with the powers to sanction proposed house/building constructions or demolish existing houses/buildings which are unsafe for human habitation in a cyclone regime or have been constructed in an unauthorised manner or not complying with the CBC.

2.300 CHOICE OF REFUGEE CAMPS/CYCLONE SHELTERS (CYSHELs) :

The possible Refugee Camps should be selected from among temples, mosques, churches, school and college buildings, and various public buildings. The Committee endorsed the recommendation of the CDMC in its Model Cyclone Plan for a coastal area in Andhra Pradesh :

CRC/268 : The District Collectors and subordinate officers who tour the CPARs should inspect all temples, mosques, churches, school and college buildings, the public buildings etc. for their suitability as cyclone shelters. This selection should be done before the cyclone season starts. The location of the Cyclone Refugee Camps/Cyclone Shelters (Cyshels) should be advertised to the public by maps affixed to notice boards in public places, schools, community centres, cinema halls, railway stations, ports, post offices, panchayat offices etc. and also published in newspapers periodically. Special pennants and pennant type baloons in orange should be flown on these shelters so that they can be seen from a long distance.

2.301 PERMANENT CYCLONE SHELTERS (CYSHELs)* CONSTRUCTED UP TO DATE :

The CDMC recommended (CDMC/25 and 26) the construction of CYSHELs in the CPARs of the coastal states and two states Andhra Pradesh and Tamil Nadu took up this suggestion very seriously indeed. The Government of Andhra Pradesh made an admirable study of the problem* and arrived at the following conclusions : Andhra Pradesh has a total coast line of 1030 km, there are about 500 villages with a total population of 11.63 lakhs within a belt 5 km wide of the coast, 60 villages with a total population of 15.20 lakhs in next 5 km belt and 1381 villages with a total population of 27.68 lakhs in the next 10 km belt. It was estimated that a total number of 1336 CYSHELs would be needed within the 20 km belt among the 1030 km sea coast. In the first phase the first 10 km belt would be provided with CYSHELs and it was proposed that 524 such shelters be built of which 380 have been completed by October 1982. Table 2.27 gives a list of these CYSHELs. In the second

TABLE 2.27**

CONSTRUCTION OF CYCLONE SHELTERS(CYSHELs) IN ANDHRA PRADESH UPTO OCTOBER 1982

District	Number proposed	Number constructed	Balance
1. East Godavari	65	38	27
2. Guntur	83	72	11
3. Krishna	142	120	22
4. Nellore	62	32	30
5. Prakasam	45	33	12
6. Srikakulam	47	31	16
7. Visakhapatnam	46	23	23
8. Vizinagram	10	7	3
9. West Godavari	24	24	0
Total	524	380	144

Number of construction completed by December 1982 = 450

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* Community Cyclone Shelter Construction Programme for Cyclone Prone Coastal Areas of Andhra Pradesh : Revenue Department, Government of Andhra Pradesh 1980.

** Information provided by Prof. P. Koteswaran and Prof. P. Ramanadham.

phase 200 more CYSHELs will be constructed. Numerous voluntary organisations came forward for these constructions in responce to the scheme of matching grant from the Chief Minister's Relief Fund. Most important among these organisations is the Red Cross Society which promised to contibute 1.5 crores to construct about 200-300 CYSHELs. The TTD has come forward to put up 30 shelters of their own, the Tata Relief Committee 17 shelters and Maharashtra Citizen Committee another 10 shelters. According to the prevailing rates a CYSHEL is expected to cost Rs.1 lakh. With regard to Tamil Nadu the assessment of the number of CYSHELs required was not available. But* it is apparent that very detailed study was made of designs by an expert panel drawn from specialists from fields of structural engineering, architecture, meteorology and town and country planning and consisted of Director of Town and City Planning, Director of Regional Meteorological Centre, Assistant Director of SERC/CSIR, Professors of Structural and Urban Engineering Department of Guindy Engineering College, Professor of School of Architecture and Planning, Chief Architect of the Government (PWD) and Senior Architect of Military Engineering Services, Southern zone. In making the designs the recommendations of the United Nations Distress Relief Organisation Coordinator (UNDRO) were kept in view. A series of alternate designs were formulated which were expected to cost Rs.2 lakhs per shelter. So far 82 CYSHELs have been built in Tamilnadu as given in Table 2.28

TABLE 2.28**

CONSTRUCTION OF CYSHELS IN TAMILNADU

District	Number constructed
1. Chengalpattu	15
2. Puddukottai	13
3. Ramanathapuram	18
4. South Aroot	13
5. Thanjavur	23
Total	82

A total of 100 CYSHELs was proposed along the 600 km Tamilnadu coast of which, as has been stated above, 82 has now been completed with the help of EEC, International League of Red Cross Societies, UNICEF, the Maharashtra Citizen Committee, Relief Association of the Government of Karnataka and funds from Tamilnadu Chief Minister's Relief Fund. This programme has drawn high praise from UNDRO, EEC, CIDA and other international organisations. There was no information available to the Committee about the progress of construction of CYSHELs in Orissa and West Bengal.

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* Anti-disaster Shelter Construction Programme for Cyclone Affected Areas of Tamilnadu : Directorate of Town and Country Planning, Government of Tamilnadu 1977.

** Information provided by Dr. C.S. Bhaskara Rao Director Regional Meteorological Centre Madras.

2.302 PRINCIPLES INVOLVED IN THE DESIGN AND USE OF CYSHELs :

With the experience gained in the construction programme of CYSHELs in Andhra Pradesh and Tamilnadu certain principles and guide lines can be noted in this matter which can be useful to other coastal states which have not undertaken these programmes so far. The Committee recommended :

CRC/269 : In matters connected to construction and use of Cyclone Shelters (CYSHELs) the following points should be kept in view :

I. Objectives and functions of the CYSHELs : It is expected that the coastal population would know well in advance to which CYSHEL they would have to take refugee. The fury of the cyclone would rarely last more than a week, but the storm waters may be expected to stand for a month some times. The units set up for CDMW would be mainly stationed at the CYSHELs and these would be expected to take care of the refugees for a period of a month (phase 3-Postcyclone period) by which time the water would recede and the refugees return to their homes. The medical/epidemic control units stationed here would not only take care of the refugees but also take preventive measures for epidemics in the locality. The relief in goods and money may also be given to the refugees at these shelters.

II. Location :

1. In places where there is acute danger of flooding due to storm surges, the CYSHELs should stand well (at least 3m above) the highest water recorded in the locality.

2. The CYSHELs should be approachable during cyclone emergencies by the refugees and the cattle. These should therefore have alternative approach roads so that they are not cut off when some roads become nonpassable due to debris and flood water. The CYSHELs should therefore be situated near the hubs of roadway net works.

3. The sites should be approved by the Collectors after detailed investigation of the environment

and neighbouring population which will use the CYSHELs built on them.

III. Design :

1. The CYSHELs may be circular, octagonal or built on rectangular modules.

2. The framed structure should be designed to stand upto a wind speed of 250 kmph and gust winds of 270 kmph in addition to dead and live loads as per National Building Code and will have an infilling of local bricks.

3. It should be a two storied building with a basement. The basement should enclose a fully protected well or bore well of required yield covered with movable inspection covers and space to house pump room/ tube wells/diesel generating set/fuel and storing space for groceries and grains. The ground and first floor should accommodate mainly the dormitories. Sufficient space should be allotted here for Cyclone Relief Administration/Security and Police/Wireless Communication Monitoring Units/ Weather Observatory/Essential Health and First-aid Medical Facilities and an Epidemic Fighting Centre with provisions for a few beds for victims needing medical attention and common kitchen and canteen/ public toilet facilities. The water tank should be under the roof level to avoid wind blast, or suitably protected against it.

4. The shelter should have minimum openings. Such windows that must be put in, should be provided with wire meshes on the outer surface and wooden shutters inside. For use of the shelters during the noncyclone reason a certain minimum number of windows have to be put in.

5. There should be at least four screen walls integrated to the frame of the main structure so that at any time during a cyclone regime at least one leeward doorway can be left open for late entrants.

6. The roof should have a slight camber at the rim for streamlining and the central area should be sufficiently reinforced to serve as a helipad for delivery of essential commodities and transportation of men by helicopters.

7. The basic design is a two storied RCC building framed structure-for circular designs dimensions

15m diameter and 7m high are capable of taking 500 refugees. But in many areas CYSHELs capable of taking 1000 people may be required.

8. The CYSHEL should be located on a site of area of about one hectare. A space of 22.5m may be kept clear round the building to facilitate movement of vehicles for transporting men and materials during cyclone emergencies. Adjacent to the CYSHEL space for weekly market/shandy (67.5m x 36m), space for cattle, agricultural products, hay etc. (67.5m x 60m) may be provided.

IV. Management and other Units stationed at the CYSHEL : The following units may be stationed at the CYSHELs :

1. Office of the CYSHEL Commandant in charge of the CYSHEL and management staff
2. Security
3. Telecommunication Office
4. Weather Office
5. Office of the Medical Officer and his staff/ Epidemic Control Centre
6. Office of the Revenue Department for giving relief to the refugees - this should be in the vicinity if not actually in the shelter.

V. Facilities : The following facilities should be provided :

1. Water tank, water pump, tube well
2. Emergency Diesel generator set
3. Public toilets and water closets
4. First aid centres, epidemic fighting centre, medical care unit, a few beds for emergencies with a stock of commonly needed medicines and epidemic preventives
5. Common kitchen and common place for eating
6. Adequate sewerage system immune to storm surge
7. Rescue gadgets like inflatable boats and light bridges, jeeps, ambulance cars etc.
8. Adequate stock of grains, groceries and fuels to last a month

9. Adequate stock of medicines and epidemic preventives for refugees not only sheltering in the CYSHEL but also the residents of the locality.

VI. Special communication channels : The police communication network should be available at the CYSHELs. If the present Police WT/VHF systems are replaced with UHF systems then each CYSHEL should be equipped with an UHF manpack transreceiver.

VII. Use of CYSHEL in noncyclone seasons : It is quite obvious that the CYSHELs should be in continuous community use throughout the year and yet would be available and ready as a cyclone shelter within hours of receipt of the'Cyclone Alert' signal. Without much continuity of use round the year the shelters would fall into decay and disrepair. The type of use evidently must be such that it can be halted at a short notice and the shelter transformed to be ready for its real use. Thus use as community hospitals, school/college laboratories, libraries must be avoided. However use as class rooms of elementary/high schools, lecture halls in colleges/ mahila mandalis/Balawadis/mangal karyalayas etc. are appropriate community use of CYSHELs.

VIII. Funds for stock at the CYSHELs and their maintenance : Adequate funds are necessary to keep the CYSHELs in a proper state to receive the refugees at a very short notice. It is therefore necessary for the Commissioner - Rescue Relief and Rehabilitation be provided with special funds out of which he may allocate money to appropriate agencies to carry out the required tasks. Without this special funds the CYSHELs would not be able to serve the purpose for which they are built.

IX. Construction Agencies : As most of the CYSHELs would be located at the rural areas, the appropriate construction agency on behalf of government would be the Panchayat Raj Engineering Department, or when there are special reasons, by the Roads and Buildings Departments.

X. Agency for maintenance : In the rural areas the Panchayat Raj Engineering Department would be the proper agency for maintenance of the CYSHELs. Any other Department of the Government may also be given this task if necessary.

2.303 PUBLIC HEALTH SYSTEM :

An important task for the State Public Health Engineering Department would naturally be to devise and instal efficient public health systems in the coastal regions. During cyclone emergencies the sewerage systems are liable to be blocked by the debris brought in by the cyclones and it is necessary to clear them as soon as possible. Also the CDAs must introduce a system for quick disposal of bodies of dead humans and animals. Finally the greatest danger following cyclone like disasters is that of epidemic coming in the wake of such disasters. The Committee recommended :

CRC/270 : The State Public Health Engineering Department should take the responsibility of establishing an efficient sewerage system in the CPARs which should be maintained and periodically repaired. A detailed sewerage map of the CPARs should be prepared by this Department.

CRC/271 : The CDAs of a coastal State should have its units for disposal of bodies of victims of cyclones and dead animals which should cooperate with similar units of the concerned State Governments. The CDA should establish common burial/cremation grounds for mass disposals of corpses and dead animals.

CRC/272 : The State Public Health Department should have units at permanent health centres with expertise to fight all kinds of epidemics. At these centres arrangements should be quickly set up after the cyclone emergency has passed, to go into operation a mass inoculation programme to prevent outbreak of cholera dysentery and similar epidemics.

2.304 PROTECTION OF AGRICULTURAL PRODUCTS :

The main danger to agriculture from cyclones is the destruction of crops caused by high winds and excessive rains and submergence for a long time under flood water. In the low lying areas of the coastal strips very little can be done by way of protection. The Committee considered these problems and recommended :

CRC/273 : The CDA of a coastal State should insist on the implementation of the land zoning laws against unrestrained agricultural use of lands in areas liable to be periodically inundated under saline water brought in by storm surges from the sea. These lands may be permitted to be used for raising such agricultural crops which can grow under saline conditions and under prolonged submergence by flood waters. The Indian Agriculture Research Institute (IARI) may be requested to advise on this matter.

The Committee also endorsed the recommendations of CDMC (CDMC/28 and CDMC/29) :

CRC/274 : Cut crops which have been already removed from the fields in the low lying inundated areas have to be stored on artificially raised platforms to protect them from storm surges. These platforms should be designed to stand up to the fury of cyclone winds and storm surges. The State Agriculture Department should also provide storing space for cut crops in sheds in the rural areas which can stand up to cyclones and storm surges.

CRC/275 : Mobile community dryers perhaps using solar energy should be provided whenever needed in the CPARs for use by the farmers to dry their crops and thereby cut their loss. The appropriate CSIR national laboratory may be requested to develop such low cost mobile driers and the concerned State Agriculture Department may put them to field trials.

CRC/276 : The Department of Environment should be consulted by the CDAs of the Coastal States regarding measures to desalinate the lands submerged under storm surges from the sea and implement them where necessary.

2.305 FACILITIES FOR FISHERMEN :

An important task of the CDMW is to devise measures for protection of fishermen at sea during cyclones. The Committee recommended :

CRC/277 : The CDA of a coastal State should establish a system of closely spaced fishing ports which need not be very elaborately equipped except that they may have storage space for fishing equipments, boats, some homing signal system and an emergency medical care unit which can be quickly set up during cyclone emergencies. During such emergencies the homing signals should guide the fishing boats to those ports where shelter can be sought and medical care given to injured fishermen. Persons should be trained to manage these ports.

CRC/278 : To facilitate rescue operations, the fishermen should be advised to fit bright orange coloured sails on their boats and generally wear shirts, vests, turbans or scarves in the same colour which can be seen from a large distance from land air or the sea.

CRC/279 : There should be R&D work on designing fishing boats which may capsize in cyclones but which would not sink easily.

CRC/280 : The State Department of Fisheries should have an arrangement of keeping a master roll of fishermen at sea at any given time and should in course of time have their own launches and helicopters to carry out search and rescue operations for missing fishermen. Officials should be trained for such reconnaissance/search operations.

2.306 CYCLONE STORES (CYSTORs) OF VARIOUS TYPES :

Since cyclone leaves the concerned State Governments very little time to prepare for the confrontation, the first phase 'Cyclone Alert' being rarely more than 24 hrs in advance, it is important to distribute the various materials/equipments at various types of cyclone stores (CYSTORs) located at strategic points of the CPARs from where they can be requisitioned at a moment's notice when the emergency arises. The CYSTORs would be of various types

1. CYSTORs for evacuation/rescue (ER-CYSTOR)
2. CYSTORs for relief/rehabilitation (RR-CYSTOR)
3. Flood Stores (FLODSTORs)
4. Medical Stores (MEDSTORs)
5. Epidemic Control Stores (ECSTORs)
6. Agriculture Stores (AGRISTORs)
7. State Transport Department Stores (STDSTORs)
8. PWD Stores (PWDSTORs)
9. Food Stores (FOODSTORs)
10. Fodder Stores (FODSTORs)

The Committee made the following recommendations about these stores and about the type of materials/equipments which are required to be stored in them.

CRC/281 : As a part of the CPPC the State Government should establish stores of various types for materials/equipments needed in a cyclone emergency, at strategic points distributed over the CPARs of the State.

CRC/282 : The stock of materials/equipments at these stores should be reviewed annually at the beginning of the cyclone seasons and replenished if necessary.

CRC/283 : One of the first steps to be taken by the District Collectors is to build up the stocks at these stores to the degree necessary as soon as the 'Cyclone Alert' signal is received by them. The materials/equipments have to be requisitioned from different Departments of the State/Central Government and different agencies. At the end of the emergency a close accounting should be done of materials/equipments used and the commandeered goods released to their original owners.

CRC/284 : Accumulation of large stock of valuable goods at one place leads to corrupt practices which should be prevented by strict vigilance by the District Collectors, who should be in administrative control of most types of stores used for cyclone emergencies.

CRC/285 : The location of these stores used in cyclone emergencies should be in close proximity but outside the parts of the CPARs which are notorious for being AsD/AsGD. This would ensure that the stored goods would remain in good condition and not be destroyed by the cyclones, and yet can be moved quickly where required as soon as the emergency conditions have relaxed a little (phase 3 - Post Cyclone period).

CRC/286 : The Cyclone Stores for evacuation/rescue (ER-CYSTOR) should store the following materials :

1. Inflatable boats, rubber tyres, life buoys
2. Emergency floating bridges of light structure
3. Grappling hooks, expandable ladders
4. Nylon/jute ropes, wires, chains, spades, crow-bars
5. Other life saving equipments
6. First aid kits.

CRC/287 : The CYSTORs for relief/rehabilitation should be equipped with the following materials which are necessary for setting up emergency Relief Camps or to supply the CYSHELs if required :

1. Tents, tarpaulines, CC sheets, asbestos sheets polythene sheets which can be used for providing temporary cover
2. Tent pegs, ropes-jute/nylon, steel poles, bamboos, slotted angled iron frames
3. Carpenters tool kits, general all purpose tool kits
4. Buckets, mobile pumps, water tanks
5. Equipments for community kitchen/canteen - large cooking vessels

6. Almirahs/storage bins

7. Emergency lighting equipments, hurricanes with kerosene, diesel generators

8. Blankets, clothes, dhotis, saris etc.

9. TC sets - in particular transistor receivers, VHF units ordinary cycles for messengers

CRC/288 : Flood Stores (FLOODSTORs) should generally store all equipments necessary for repairs of embankments and breach filling machineries, The machineries for breach fillings should include

1. Proclain, 2. Dozer, 3. Tippers (with rocking bodies),
4. Zeeps with winches

CRC/289 : Medical Stores (MEDSTORs) should generally stock general medicines for nervour breakdown, excessive exposure to wind and water, intestinal disorders, vaccines and vitamins. The stock should be furnished by State Public Health Department.

CRC/290 : Epidemic Control Stores (ECSTORs) should generally stock all types of drugs/medicines/chemicals for control of epidemics like cholera/dysentery and remedies for water pollution : chemicals like alum and filtering equipments.

CRC/291 : Agricultural Stores (AGRISTORs) should generally stores various types of seeds/agriculture tools/ mobile crop driers which can be loaned to the refugees or given as outright grant for rehabilitating them.

CRC/292 : State Transport Department Stores (STDSTORs): As the State Transport Department is expected to play a big role in evacuation/rescue operations, it is advisable to set up a number of garages/workshops/spare part depots all grouped under the class STDSTORs at appropriate places in the CPARs. These can be the collecting points of the requisitioned vehicles as well as the places where they can be maintained and repaired during the emergency.

CRC/293 : Since the PWD is expected to play a major role in clearing debris from the roads and knock down damaged buildings which are sources of danger to the public during the cyclone emergency, the Department should det up their Stores (PWDSTORs) at appropriate places in the CPARs. These stores should stock equipments like bulldozers/tractors with winching arrangements perhaps obtained during the emergency from the Agro Industrial Complexes in the State. These stores should also contain sufficient stocks of building materials :

bricks/cement/sand etc. for carrying out expeditiously the programme of restoration of public life. There should be also in these stores sufficient sand bags which can be used to seal up water entry points of important public buildings/ utilities.

CRC/294 : Very important from the point of all disasters are the Food Stores (FOODSTORs). The purpose of helping the victims is no doubt served by the various SILOEs of the Food Corporation of India and the other stores of the State Government. But from the point of view of cyclone emergencies the time available to move the food materials to the danger points is very limited. Thys extra FOODSTORs should be set up in the CPARs stocking

1. Food grains like rice/wheat/dal etc.
2. Precooked/preprocessed food materials like puffed/ pressed rice/flour/powdered dal etc.
3. Cooking media like mustard oil/coconut oil/ground nut oil
4. Cooking masalla of various types
5. Simple vegetables like potatoes which can be stored without much trouble over short intervals of time
6. Fuel for cooking wood/coal/kerosene etc.

CRC/295 : Fodder Stores (FODSTORs) should be established at appropriate places in the CPARs at close intervals. Every year a part of the fodder harvested should be set aside by the State Government and stored in the FODSTORs for use during the cyclone and other emergencies.

2.307 GARAGING/PARKING FACILITIES FOR COMMANDEERED VEHICLES :

A large number of vehicles will have to be commandeered/ requisitioned during a cyclone emergency. A part of these vehicles can be kept at the STDSTOFs mentioned in CRC/292. For the rest other storing places would be required. The Committee recommended :

CRC/296 : These commandeered/requisitioned land vehicles for which place can not be found for garaging/parking at the STDSTORs should be parked at other places where permanent structures for these purposes should be provided by the State Government as a part of its CPPC.

CRC/297 : The Irrigation and Waterways Departments of the State Government should set up gathering places along the river sides, the sea coasts and at the various ports for the commandeered/requisitioned water vehicles. The necessary structures for this purpose should be built up by the State Government as a part of its CPPC.

2.308 LEGISLATIVE MEASURES :

Many legislative measures would be necessary to evolve an effective coastal management system. The Committee has already recommended (Recommendation CRC/2) that some of the aspects relevant to cyclones should be dealt with by the ACC. But it is well realised by the Committee that the actual task of enforcing these laws should be assigned to the State CDAs for these would be directly concerned with almost all aspects of coastal management. The Committee therefore recommended :

CRC/298 : The CDAs of the different coastal states should establish close liasion with the ACC through the concerned SCYCs for generating the legislative measures necessary for preparing the Community against cyclones. The CDAs should be assigned the task of enforcing the laws laid down for all aspects of coastal management/development and given the necessary power/authority.

2.309 TRAINING OF STATE OFFICIALS AND VOLUNTARY WORKERS INVOLVED IN CYCLONE MANAGEMENT :

For microscale disasters like fires, train or air accidents etc. the normal training given to the concerned officials should be sufficient. But for macroscale disasters like drought, cyclones, floods, storm surges and earthquakes etc. involving large sections of the populations facing large scale deaths and loss of property/production/means of livelihood it is necessary to treat these as requiring the modern techniques of System Management. It is therefore necessary for the Coastal States to have a pool of officials specially trained in these techniques so that they can put into operation the various codes for the different disasters effectively without losing time and thus bring prompt relief to the affected people. The Government of Tamilnadu has given some thought of this problem which may serve as guide lines to other States. Table 2.29* gives an augmented list of different types of training necessary for antidisaster programme.

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* Anti-Disaster Plan Tamil Nadu - Government of Tamil Nadu 1978.

TABLE 2.29

DIFFERENT TYPES OF TRAINING FOR ANTI-DISASTER PROGRAMMES

Type of personnel	Objective	Method and subjects of training
1. Administrative, Supervisory and control staff	Crisis Management	(a) Simulation of disaster through models (b) Management games (c) Warning recognition (d) Review and discussion of disaster case studies (e) Post disaster management
2. Voluntary squads home guards, territorial army etc.	(a) Life saving (b) Handling of materials - errection of structures, bridges, inflatable rafts and boats and expertise for rendering first aid etc. (c) Medical attention, inoculation etc. (d) Restoration of communication (e) Clearing of roads (f) Maintenance of water supply, repair of sewerage (g) Purification and processing of water (h) Evacuating rescue and setting up of transit camps (i) Running a cyclone shelter (j) Relief distribution (k) Transmission of message through any available TC channel (l) Assessment of damages-crops, strutures and other loss of property and of deaths and injuries to humans and cattles (m) Disposal of caracasses	(a) Handling of special equipments - rafts, winches, tools etc. (b) Signalling techniques - Simple Morse etc. (c) Organisation of evacuation (d) Prevention of epidemics

Type of personnel	Objective	Method and subjects of training
	(n) Removal of debris (o) Patrolling, maintenance of law and order, protection of property	
3. Special non official post disaster committees	(a) Collection of funds and control of relief work (b) Preparation of reports	(a) Liasing with Voluntary agencies (b) Methods of contact (c) Reporting methods

The items listed in table 2.29 are by no means complete and should be supplemented by the other items in the light of experience gained. The Government of India should assist the States in formulating these disaster management training programmes. The Committee recommended :

CRC/299 : The coastal states should build up a pool of officials specially trained in the techniques of cyclone management in all its aspects and other disaster management out of which personnel can be drawn and allotted special tasks in a cyclone emergency for mitigating the distress caused. The items and methods of training should be carefully selected and constantly updated in the light of experience gained. The Government of India should come to the assistance of the State Governments in this Disaster Management training programmes (DMTPs).

2.310 EDUCATING THE PUBLIC :

To have an efficient response from the public in the CDMN, it is necessary to inform them of the nature of cyclones, their hazards and the ways and means to confront them. The Committee felt that one of the responsibilities of the CDAs should be to undertake this with the help of the IMD, and such other agencies/appliances as AIR, Doordarshan, the Community TV circuits of INSAT etc. and the news media. The Committee was informed that after the 1977 Andhra Pradesh Cyclone the IMD has made a documentary on cyclones which was shown in the cinema circuits of India. The Committee recommended :

CRC/300 : The Film Division of the Ministry of Information and Broadcasting should prepare with the help of the IMD a series of documantaries and video tapes on cyclones to inform the viewers about the nature of cyclones, their hazards and the devastations they cause, the ways and means to confront them and what to do during cyclone emergencies. These documentaries and video tapes can be shown to the general public just before and during cyclone seasons in cinemas, through Doordarshan and rural community TV circuits of the INSAT. In particular the films and tapes advising the public what they must do in emergencies, should be shown very frequently to viewers in the CPARs. The State Public Relation Department may be given the responsibility of organising the presentation of these visual materials to the public.

CRC/301 : The AIR should arrange frequent broadcasts of suitable programmes about cyclones - their nature, their hazards and the devastations they cause, how to confront them, and what should the people do during cyclone emergencies. These broadcasts should be arranged just before and frequently during the cyclone seasons taking special care that they are directed to listerers in the CPARs. The broadcasts can be included in the school broadcast programmes and in community programmes directed to rural listeners.

CRC/302 : The State Public Relation Department may seek the help of the local newspaper media to inform the public about cyclones, their origin and nature their hazards and the devastations they cause, how to fight them and in emergencies what to do. This should be done through articles written by experts of the IMD, which should appear frequently in the newspaper during cyclone seasons particularly in those circulating in the CPARs.

CRC/303 : The State Public Relation Department should circulate booklets/pamphlets on cyclones in the rural areas in the CPARs through the gram panchayats. These booklets should contain specific informations for the rural population how to meet cyclones and in particular what to do during cyclone emergencies. The booklets may be prepared with the help of the IMD. They should be in local languages and should be available at nominal prices from government stationery shops, book shops, Railway stations and prominent places where people assemble.

CRC/304 : The CDA should prepare cheap pamphlets for circulation among the public in the CPARs contain advisories and codes of constructing cyclone proof huts/buildings.

The Committee also endorsed the recommendation of the IMD (IMD-CP/12(1)).

CRC/305 : The IMD should establish a publicity cell in each ACWC/CWC which will work in collaboration with the news media, AIR, Doordarshan, and the State Publicity Department to educate the public of the CPARs about cyclones - their nature, hazards, measures for community preparedness, and instructions required to be followed in emergencies.

2.311 EDUCATION AT SCHOOL LEVELS COVERING CYCLONES :

The syllebi - for elementary classes upto Class VI in Phillipines cover the topic of typhoons. The Committee also felt that the syllebi of the elementary schools in India should also similarly contain cyclones to make the children familiar with this type of disaster right from their early formative period. The curriculum for cyclones in Burmese Schools is given in appendix 2.21 paragraph 2.381. The Committee recommended :

CRC/306 : The Directors of Public Instructions (DPIs) in the coastal state should ensure that the syllebi of Indian schools at the secondary level should include the subject of cyclones in very elementary and descriptive terms with informations about some famous Indian cyclones and also regarding what to do during cyclone emergencies as has been done in Burmah, Phillipines and other countries. The National Council of Educational Research and Training (NCERT) should arrange the publication of suitable text books for the schools to cover these topics.

CRC/307 : Frequent seminars should be arranged by the State Government in collaboration with the IMD and other agencies at schools on subjects covering the causes of disasters, their prevention, mitigation of distress caused by them to people including measures for relief, rehabilitation, reconstruction and restoration of normal life. State Officers in charge of relief and other experts should be invited to give talks on these subjects at these seminars.

2.312 CYCLONE CLUBS :

In order to make the public aware of the problems related to cyclones, it was suggested that the cyclone clubs should be formed to follow the life cycles of Indian cyclone. Amateur telescope clubs exist in this country which have aroused much interest in astronomy among the young people. It is hoped that cyclone club would serve a similar purpose. It was reported that there were such clubs in Andhra Pradesh. The Committee recommended :

CRC/308 : To generate interest in cyclones, Cyclone Clubs should be formed in the Coastal States. An important activity at the Cyclone Clubs should be to monitor the CWM broadcasts over the AIR, and to keep records of tracks, movements and other parameters of various cyclones like wind speeds and pressure depths and also of various other informations like the extent and categorisation of damages caused by them in those States. These clubs should also arrange group discussions on the cyclone problem. In times of cyclone emergencies they can contribute directly by volunteering in cyclone distress mitigation operations. The work of these clubs would help to a very great extent to spread awareness of the cyclone problem among the general public.

2.313 NEED TO REVIEW THE EXISTING RECOMMENDATIONS OF THE VARIOUS STATE CDMCs :

In Chapter 7 (paragraph 7.1, 7.5, 7.8) a review has been made of the status of implementation of the recommendations of the various State CDMCs. After these recommendations were made the country has been visited by many severe cyclones and much experience has been gained in Cyclone Monitoring/Warning/Distress Mitigation. That a good system is being built up for facing cyclones is seen from the fact that there has not been again loss of life in a cyclone disaster of the magnitude caused by the 1977 November Andhra Pradesh Cyclone. The Committee felt that since the Cyclone problem has been reviewed once again and the Committee has made recommendations about various aspects of it, in particular with regard to Cyclone Code and Community Preparedness Plan which are of direct concern to the coastal State Governments, the State CDMCs may review their past recommendations. The Committee therefore recommended :

CRC/309 : The recommendations of the State CDMCs should be reviewed specially with respect to the CEAPs of these States and their CPPCs in light of further experience gained with respect to cyclone disasters and the recommendations made by the Cyclone Review Committee. While formulating the CEAPs the established administrative practices prevalent in the concerned States should be kept in view.

VII. CYCLONE RESEARCH AND TRAINING

2.314 NEED FOR RESEARCH ON CYCLONES :

Though man has suffered from cyclones over the ages, there remains much that is still not understood about the phenomenon. It will be noticed that cyclone warning is based only on the maintenance of constant watch on the storms, which are known to be erratic, and not on any scientific understanding of their nature of behaviour. Since the Indian region is the cradle of large number of devastating cyclones, there is a great opportunity for detailed studies on them; consequently there should be continuing research programmes on this type of storms. The Committee noted that a beginning has been with the establishment of a Cyclone Research Centre at Madras. The Committee endorsed the recommendation of the IMD (IMD-CP/9).

CRC/310 : It is important to organise continuous research on Indian cyclones to improve the forecasting capabilities and methods of detecting and tracking them.

The Committee endorsed the recommendation of IMD (IMD-CP/14).

CRC/311 : The Cyclone Warning Research Centre at Madras should be expanded into a National Cyclone Research Centre which should be responsible not only for research on Indian Cyclones but also for development/assessment of forecasting techniques.

2.315 NEED FOR INVOLVING THE UNIVERSITIES AND OTHER AGENCIES IN CYCLONE RESEARCH :

It is unfortunate that not much interest has been roused in the Indian Universities and various research agencies about research programmes on cyclones. The Committee noted that the IMD has made a start in funding research projects in meteorological topics in the different Indian Universities and the Indian Institutes of Technology particularly the one at Delhi. The Committee recommended :

CRC/312 : There is a need for the Indian Universities and the Indian Institutes of Technology and various research agencies in India to organise research projects on tropical cyclones.

2.316 RESEARCH ON STORM SURGES : The phenomenon of storm surges caused by cyclone is not well understood either. Recently under the sponsorship of the IMD, IIT-Delhi has started a research group on storm surges. Much valuable work has been done also at the IMD to develop some models for predicting heights of storm surges on the eastern coast of India. These models have achieved some measure of success. An important parameter for these forecasts seems to be the central pressure fall in a cyclone. The Committee recommended :

CRC/313 : There should be well supported research projects on cyclone caused storm surges, their origin and their identification, and on the various parameters determining their nature and development. This may be organised by the IMD in collaboration with the Department of Oceanography.

2.317 NEED FOR RESEARCH ON INTERACTION OF RIVERS WITH STORM SURGES :

Since the state of the rivers in the CPARs contribute in a mjor way to the magnitude and character of cyclone caused storm surges, there is also a great need for understanding this interaction. The Committee endorsed the recommendation of the CDMC (CDMC/10) in a more extended form :

CRC/314 : Model studies on the rivers in the CPARs should be undertaken by the IMD in collaboration with the Central Water Research Station at Pune to understand the interaction of the state of these rivers with the cyclone caused storm surges and devise techniques for forecasting the extent of interactions caused by rainfall, wind action and storm surges induced by cyclones in various sectors of the CPARs, taking into consideration the state of the rivers there during cyclone regimes.

2.318 RESEARCH ON CYCLONES BASED ON AIRCRAFT PROBING OF CYCLONES (APC) :

In paragraph 2.72-2.74 the case for monitoring a cyclone to measure its parameters and its three dimensional structure by APC does seem to be a very well established technique today and it is obviously the most direct way of studying cyclones. Apart from the operational value of this technique for cyclone monitoring, it is evidently the most direct and accurate method of data sensing and acquisition being of the class of insitu investigation. All this studies and data are evidently of great value in understanding Indian cyclones. Any project of aircraft probing of cyclones must be multidisciplinary and multiinstitutional. The I.M.D. must play a major role in any such project but other research organisations like the Universities, Indian Institutes of Technology (IITs) and the various research institutes must also play a vital part at least for investigations on cyclones. Much thought and planning must go in any APC project which is bound to be very expensive. The APC programme for USA has been reviewed in Chapter 4 paragraph 4.121-4.124. The Committee discussed various aspects of this item and recommended :

CRC/315 : A national multidisciplinary and multi-institutional project may be initiated by the DST for aircraft probing of cyclones/other weather disturbances like thunderstorms/norwesters. The aircrafts can be used also to monitor and study the behaviour of clouds and monsoons.

CRC/316 : A team of experts may be sent to visit countries like USA/Japan where the technique of probing by aircraft has reached a high level of perfection with the objective to find out the economic viability, aspects of training/operation plan/flight operation/data collection in flight and the potential for research of this technique.

2.319 SPECIAL TRAINING OF METEOROLOGISTS NEEDED FOR THE CYCLONE PLAN :

For the Cyclone Plan which is being recommended in this report, a large contingent of scientists, technicians and specialists would be needed for its successful operation. The Committee endorsed the recommendation of the IMD(IMDCP/13) :

CRC/317 : For successfully operating the Cyclone Plan suggested by this Committee, quite a large number of specialists should be trained abroad and in this country in cyclone forecasting/warning work, techniques of interpretation of data obtained by different techniques of cyclone observations, who would in turn in course of time, generate a band of competent meteorologists needed in the Cyclone Plan.

सत्यमेव जयते

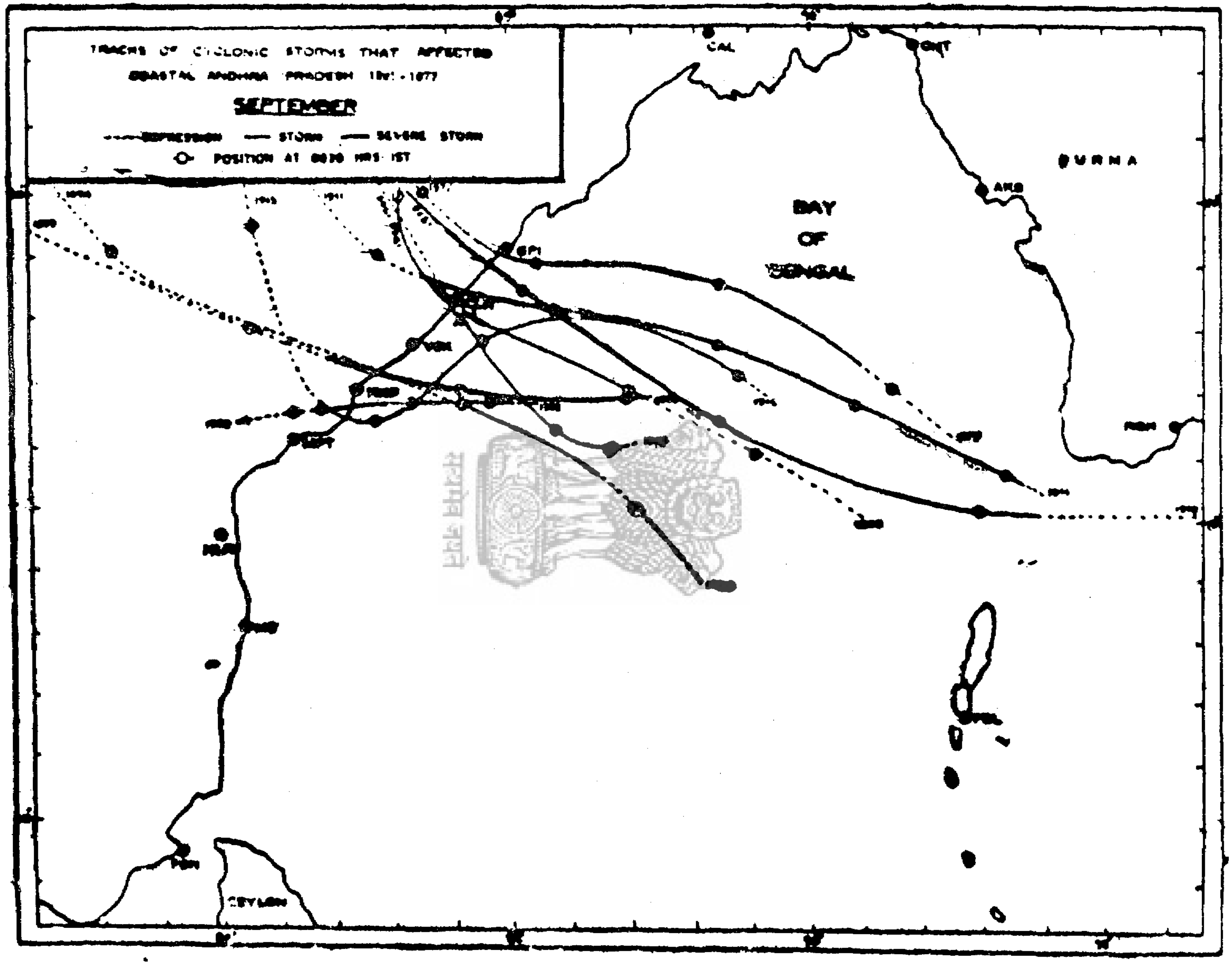

Fig.2.33 : Cyclones landfalling in Andhra Pradesh in September during 1891-1977 : Tracks. Reference 87.

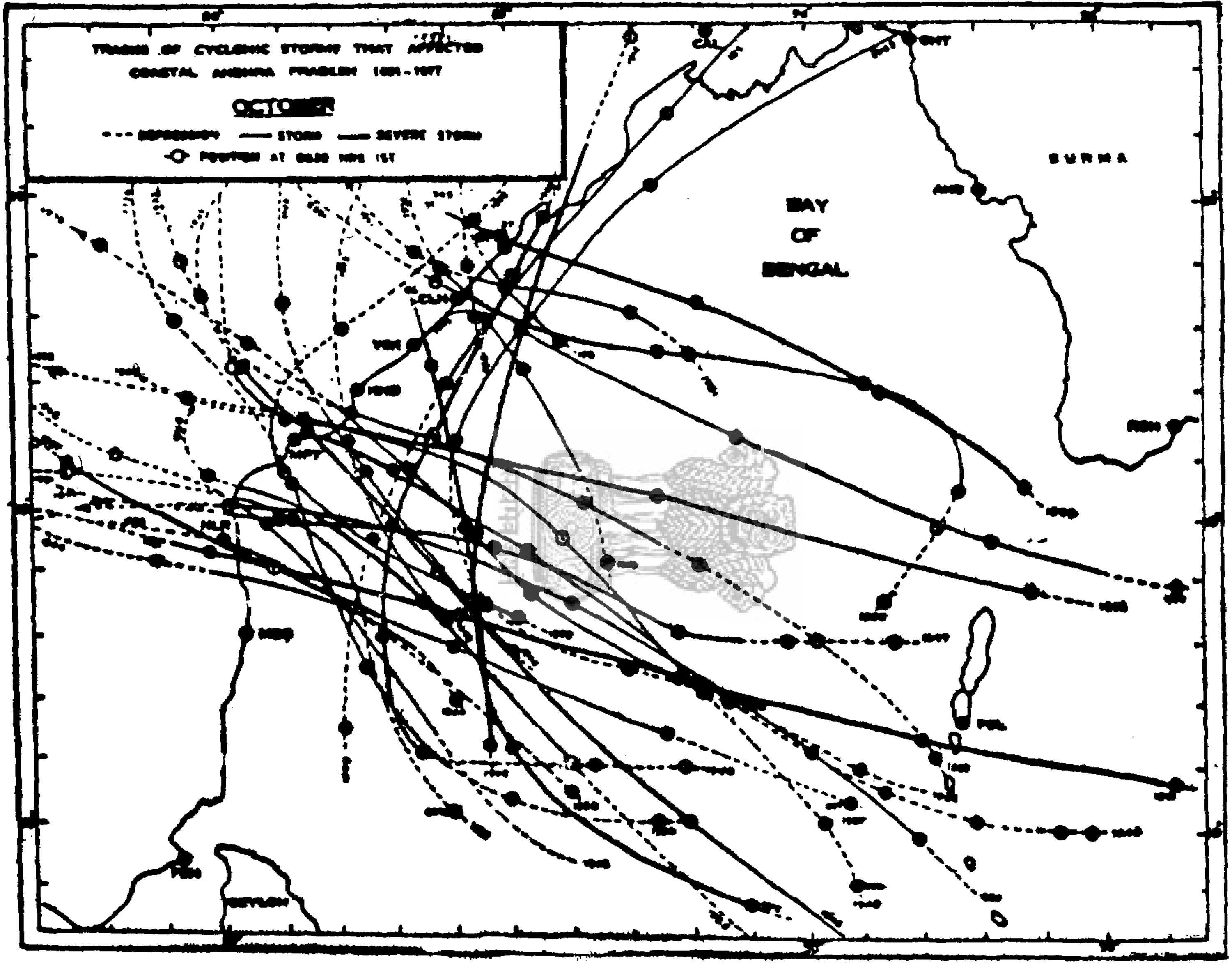

Fig.2.34 : Cyclones landfalling in Andhra Pradesh in October during 1891-1977 : Tracks. Reference 87

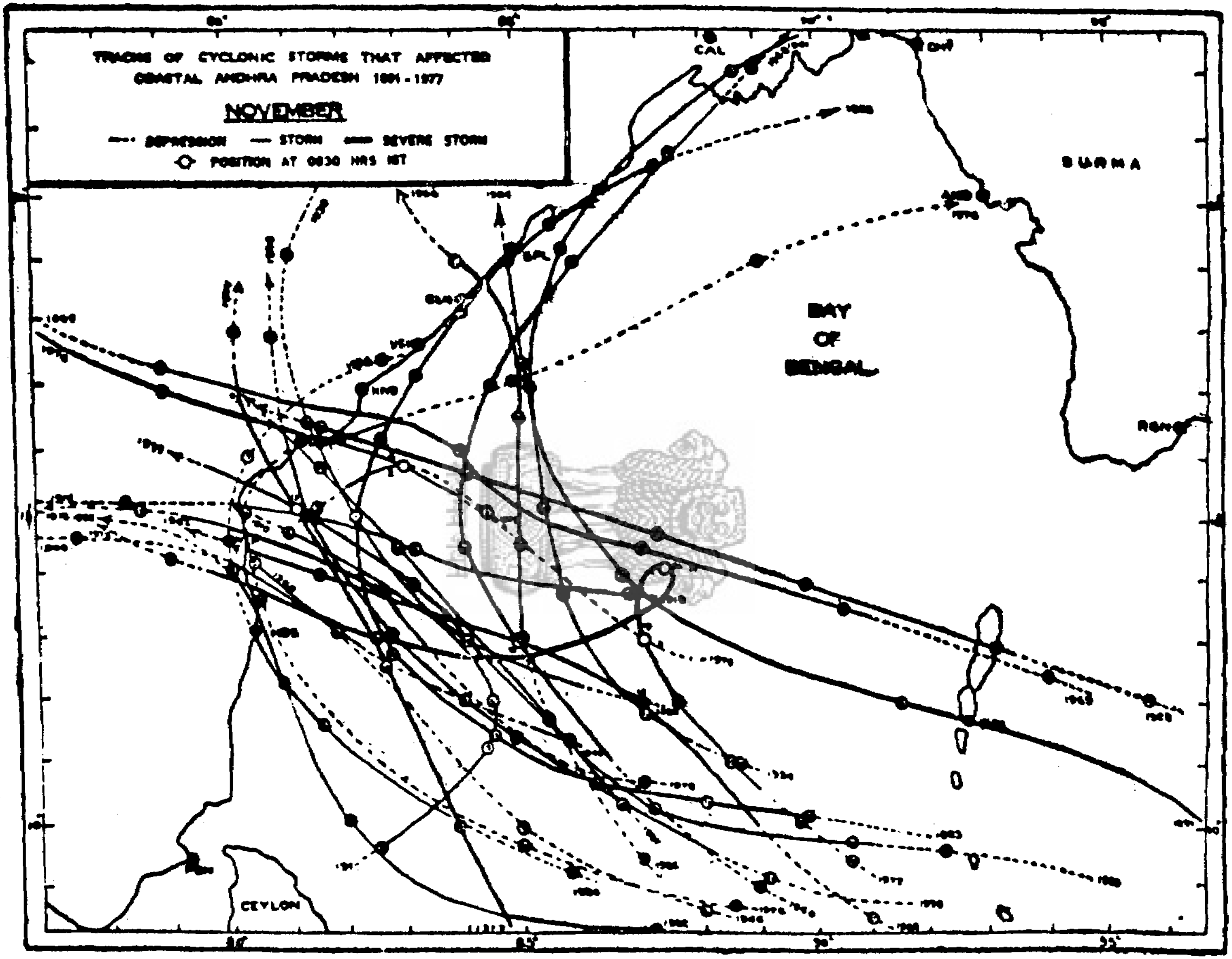

Fig.2.35 : Cyclones landfalling in Andhra Pradesh in November during 1891-1977 : Tracks. Reference 87.

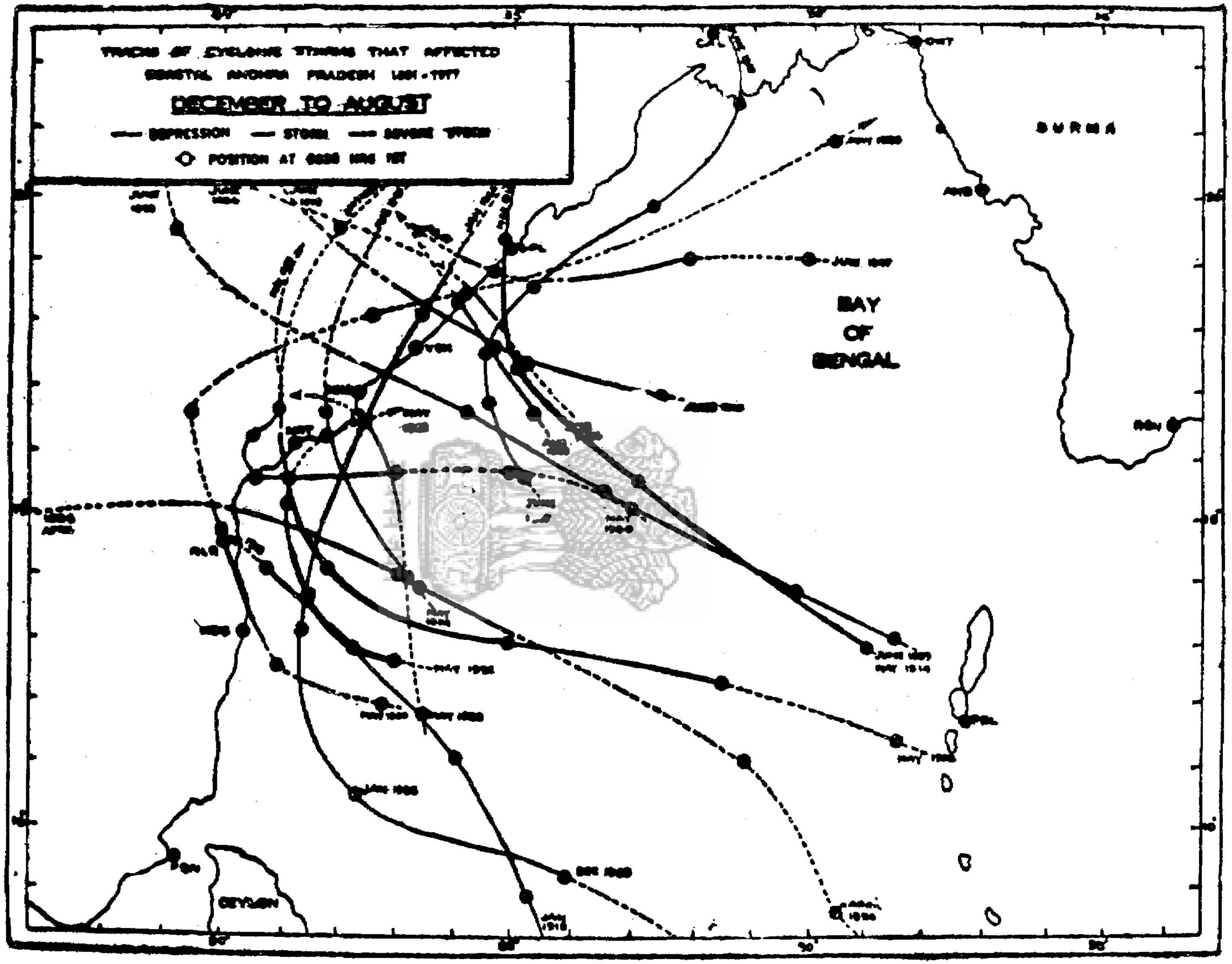

Fig.2.36 : Cyclones landfalling in Andhra Pradesh in December-August in 1891-1977 : Tracks. Reference 87

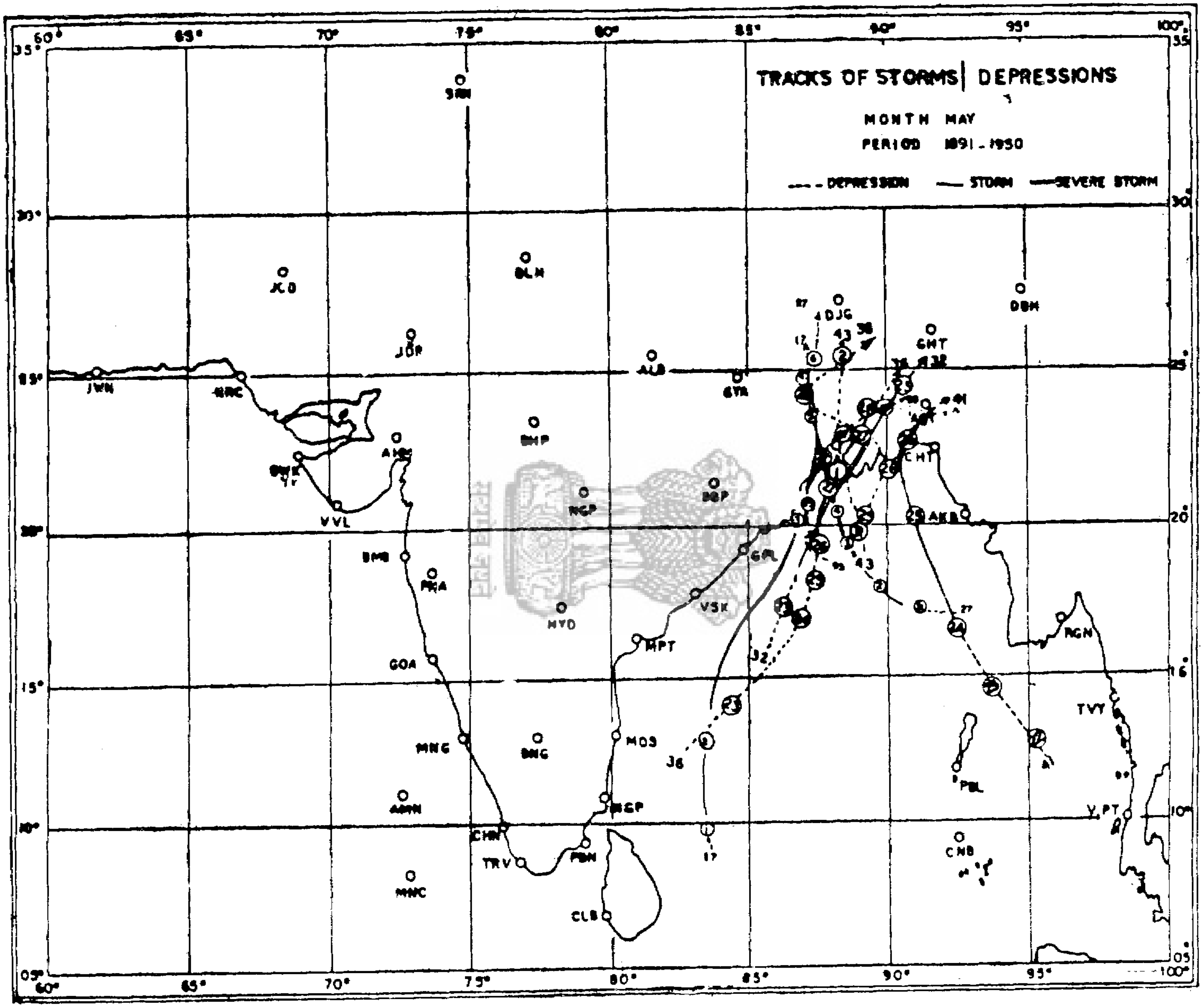

Fig.2.37 : Cyclones landfalling in West Bengal in May during 1891-1950 : Tracks.
Reference 98

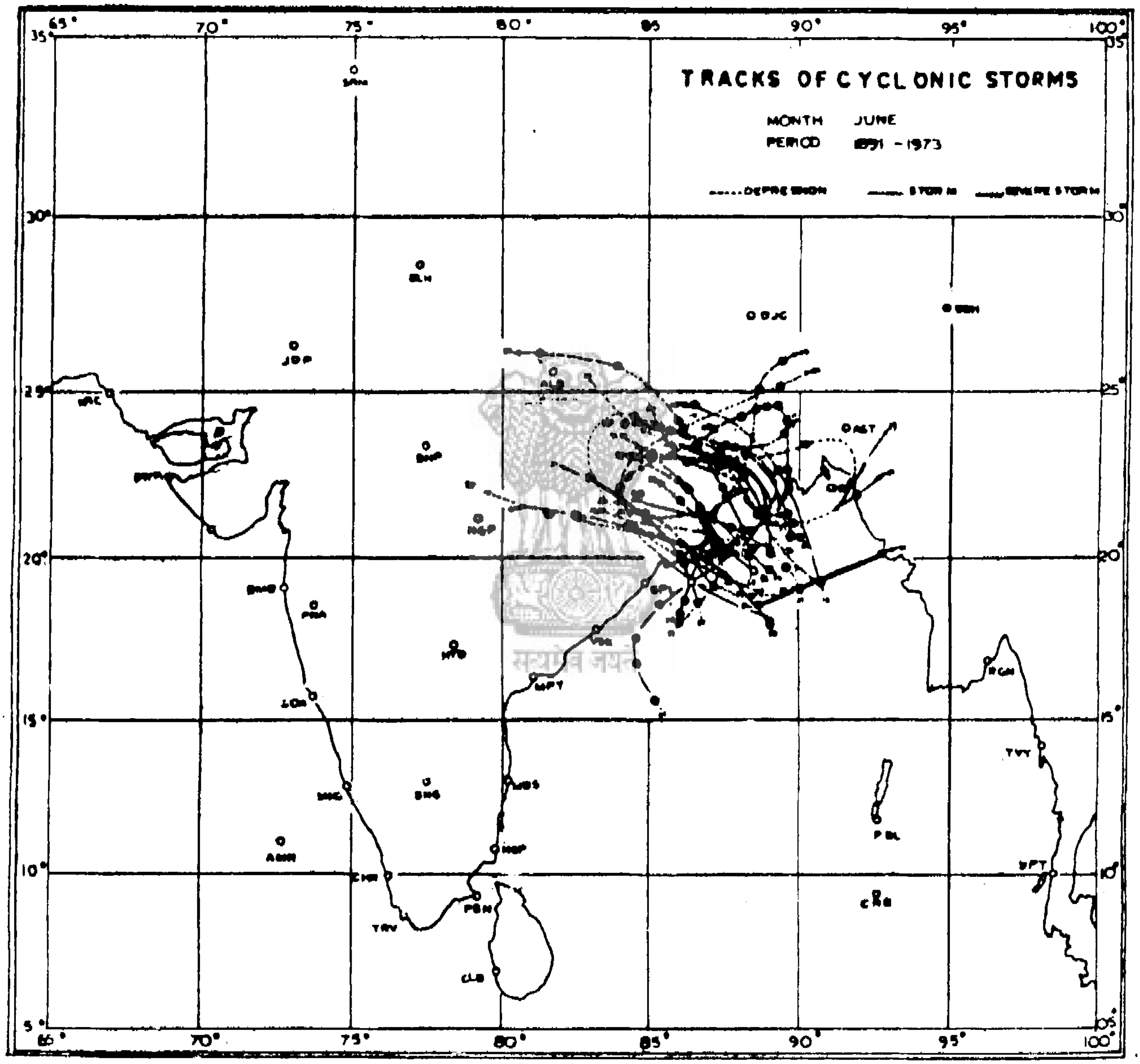

Fig.2.38 : Cyclones landfalling in West Bengal in June during 1891-1950 : Tracks. Reference 98

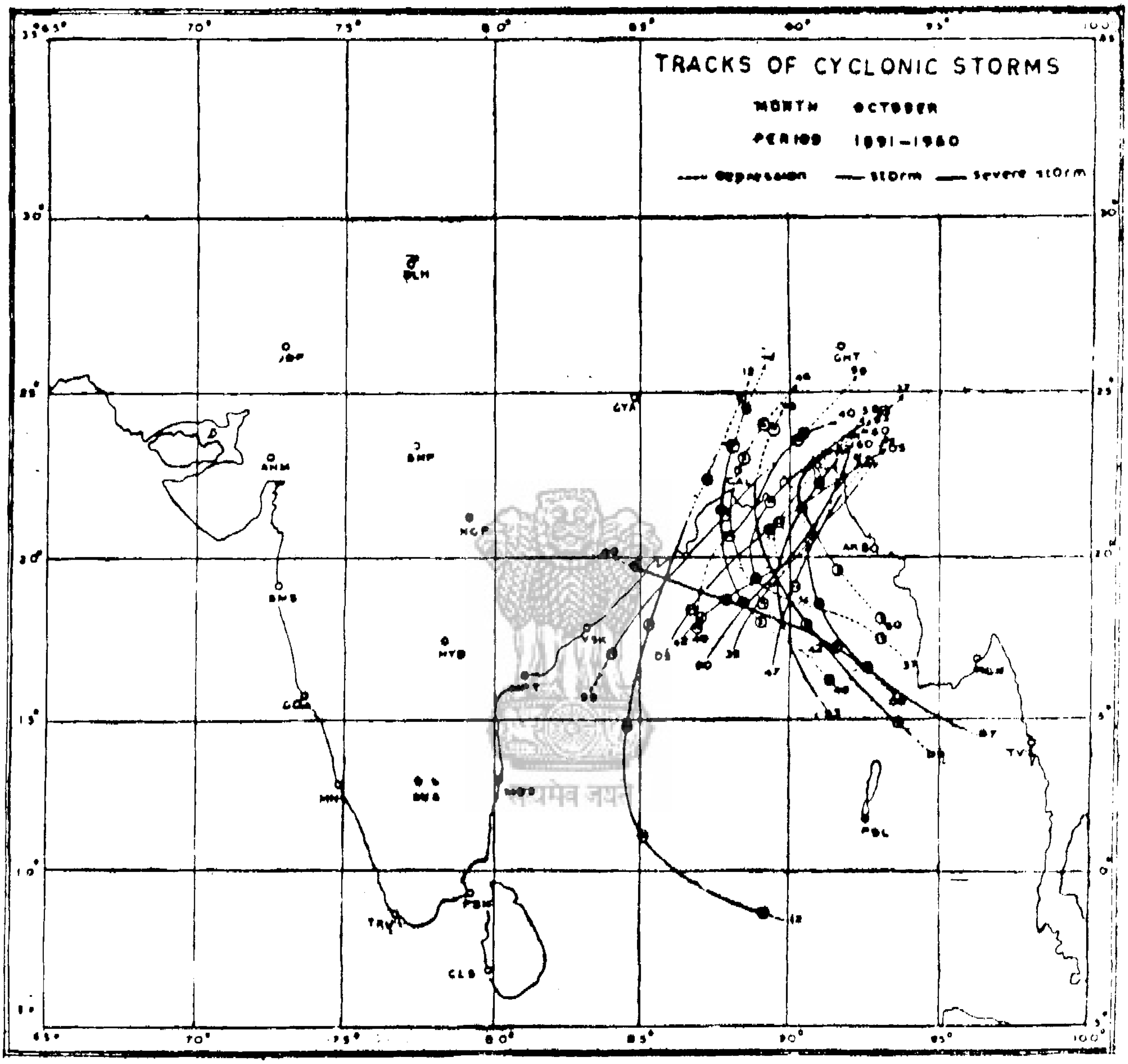

Fig.2.39 : Cyclones landfalling in West Bengal in October during 1891-1950 : Tracks. Reference 98

Appendix 2.1 : Cyclone Statistics for the eastern coast of India.

2.319 CYCLONE STATISTICS FOR THE BAY OF BENGAL AREA :

In paragraphs 2.15-2.17 some statistics have been given of cyclone as collected from the working papers circulated by the IMD among the members of the CRC. The storms have been selected on certain criteria which have not been uniformly followed causing some discrepencies in tables 2.1 and 2.2. It is however clear that the Bay of Bengal is far more important from the point of view of cyclone genesis than the Arabian Sea. In this appendix the Bay will be examined in some detail from the point of view of cyclone statistics. Further information will be available from the paper of D.A. Mooley and C.M.Hohile[1]. Table 2.30 gives the incidence of cyclonic storms severe cyclonic storms on the different sections of the Bay coast during 1877-1980.

Table 2.30

Incidence of cyclones/severe cyclones at different sections of the coast of the Bay of Bengal during the period 1877-1980.

Figures left of / indicate cyclones, and right of / indicate severe cyclones

Period	India			Neighbouring countries				Total
	Andhra Pradesh	Tamil Nadu	Orissa/ W.Bengal	East India	Arakan	Bangla Desh	East Sri Lanka	Bay Coast
Jan.	1/1	3/0	0/0	4/1	0/0	0/0	1/0	5/1
Feb.	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Mar.	0/0	2/2	0/0	2/2	0/0	0/0	1/1	3/3
Apr.	1/0	1/0	0/0	2/0	7/4	2/2	0/0	11/6
May	6/3	7/4	8/7	21/14	15/9	13/9	0/0	49/32
Apr-May	7/3	8/4	8/7	23/14	22/13	15/11	0/0	60/38
June	4/0	0/0	24/3	28/3	1/1	11/2	0/0	40/6
July	1/0	0/0	36/7	37/7	0/0	4/0	0/0	41/7
Aug.	1/0	0/0	29/4	30/4	0/0	1/0	0/0	31/4
Sept.	5/3	0/0	29/8	34/11	0/0	2/1	0/0	36/12
Jun-Sept	11/3	0/0	118/22	129/25	1/1	0/0	0/0	148/29
Oct.	27/7	6/1	20/9	53/17	5/1	16/10	0/0	74/28
Nov.	20/12	27/17	9/5	56/34	8/3	8/3	3/2	75/42
Dec.	2/0	12/7	0/0	14/7	2/0	6/4	7/1	29/12
Oct-Dec.	49/19	45/25	29/14	123/58	15/4	30/17	10/3	178/82
Annual	68/26	58/31	155/43	281/100	38/18	63/31	12/4	394/153

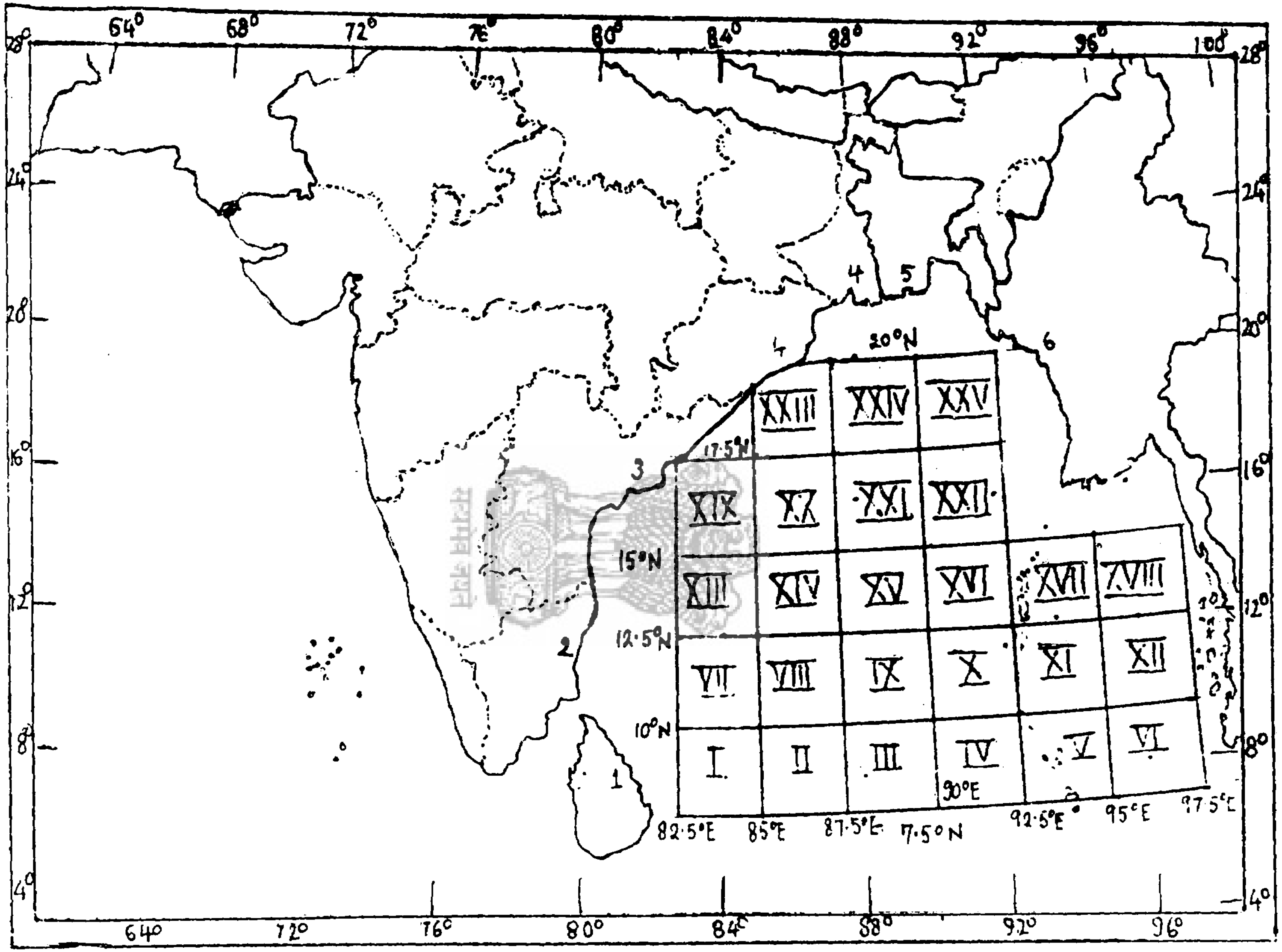

Fig.2.32 **Sectorisation of the Bay of Bengal for locating the places of origin of cyclones during the period 1877-1980 and of the countries on its coast for locating the landfall points.** Reference 56.

The following facts stand out from table 2.30

1. In the regions East Sri Lanka to Andhra Pradesh and Bangla Desh frequency of cyclones/severe cyclones is maximum in the post monsoon cyclone season i.e. for the period October-December.

2. In the regions Orissa/West Bengal and Arakan coast the frequency of cyclones/severe cyclones is maximum in summer (April-May) and monsoon (June-September) seasons respectively.

3. If the year is considered as a whole Orissa and West Bengal have the highest number of cyclones/severe cyclones.

Table 2.31 gives the break up of the incidence of the storms in various decades in the period 1881-1980.

Table 2.31

Number of cyclones/severe cyclones in different sections of the Bay coast in different decades between 1881-1980.

Figures left of/indicate cyclones, and right of/indicate severe cyclones

Decades	Indian Coast Andhra Pradesh	Tamil Nadu	Orissa/ West Bengal	East India	Neighbouring countries Arakan	Bangla Desh	East Sri Lanka	Bay
1. 1881-90	8/2	9/3	17/4	34/9	3/1	5/0	0/0	42/10
2. 1891-1900	6/1	2/2	27/6	35/9	5/2	7/6	0/0	47/17
3. 1901-10	8/1	3/0	15/4	26/5	4/3	7/1	3/1	40/10
4. 1911-20	6/1	3/2	15/6	24/9	5/3	4/2	3/0	36/14
5. 1921-30	6/5	8/3	14/1	28/9	10/2	7/2	1/1	46/14
6. 1931-40	7/3	9/4	18/6	34/13	4/2	3/0	0/0	41/15
7. 1941-50	6/2	5/3	17/4	28/9	0/0	4/2	0/0	32/11
8. 1951-60	6/1	3/2	10/2	19/5	1/0	3/2	0/0	23/7
9. 1961-70	7/4	10/7	9/3	26/14	3/2	14/12	3/1	46/29
10. 1971-80	8/6	4/3	13/7	25/16	3/3	9/4	2/1	39/24

The following facts can be observed from Table 2.31.

1. East Sri Lanka was free from cyclones/severe cyclones in decades 1, 2, 6, 7, 8.

2. Tamil Nadu was most infested with cyclones/severe cyclones in decades 1, 5, 6, 7, 9.

3. Andhra Pradesh had more or less uniform distribution of cyclones/severe cyclones over all the decades.

4. Orissa/West Bengal also had more or less uniform distribution of cyclones/severe cyclones over all the decades. There was an unusual high peak in decade 2.

5. Arakan coast suffered less from cyclones/severe cyclones and the distribution is fairly uniform except for an unusual peak in decade 5 and practically no storms in decades 7, 8.

6. Decadewise distribution for Bangla Desh parallels closely that for Tamilnadu, except there is a large peaking in the recent decades 9, 10.

Table 2.32 gives the number of cyclones N and the ratio R of the number of severe cyclones to cyclones in 25 year periods from 1877 to 1980.

Table 2.32

N the number of cyclones and R the ratio of severe cyclones to cyclones in 25 years period from 1877 to 1980 areawise.

Period	N	India				Neighbouring countries			Total
	R	Andhra Pradesh	Tamil Nadu	Orissa West	East India	Arakan	Bangla Desh	East Sri Lanka	Bay Coast
1877-	N	14	13	46	72	8	13	0	93
1902	R	0.21	0.54	0.24	0.29	0.37	0.46	-	0.32
1903-	N	19	10	39	68	17	15	7	107
1928	R	0.37	0.40	0.26	0.31	0.47	0.33	0.29	0.34
1929-	N	14	19	41	71	7	9	0	89
1954	R	0.36	0.47	0.24	0.32	0.29	0.22	-	0.30
1955-	N	21	16	29	66	6	26	5	103
1980	R	0.52	0.69	0.41	0.52	0.83	0.69	0.40	0.57
1877-	N	54	49	134	235	33	45	8	321
1964	R	0.30	0.49	0.25	0.31	0.39	0.42	0.37	0.33
19 -	N	14	9	21	44	5	18	4	71
1980	R	0.71	0.78	0.48	0.61	1.00	0.67	0.25	0.63
1877-	N	68	58	155	279	38	63	12	392
1980	R	0.38	0.53	0.28	0.35	0.47	0.49	0.33	0.39

Table 2.33 gives the highest 16 year period value of R the ratio of severe cyclones to cyclones.

Table 2. 33

The highest 16 year period value of R the ratio of severe cyclones to cyclones

	Area of coast	Highest value of R	Number Cyclones N	Year
A.	Indian Coast			
	Andhra Pradesh	0.60	10	1918-33
	Orissa/West Bengal	0.43	21	1908-23
	Tamil Nadu	0.60	10	1935-50
	East India	0.44	36	1908-23
B.	Neighbouring Countries			
	Arakan	0.70	10	1908-23
	Bangla Desh	0.60	10	1886-1901
C.	Bay	0.49	59	1908-23

Too much significance must not be read from these tables as an increasing ratio of severe cyclones to cyclones in the recent periods may be explained by two reasons : 1) more severe cyclones are now detected as a result of improvement of technology of cyclone monitoring and 2) uncertainity in the determination of cyclone intensities from satellite/radar imageries because of absence of APC in the Indian regions. Ofcourse it may be true that synoptic situation have lately contributed to the intensification of more cyclones to severe cyclone stages. Some analysis has also been done of the locations of the origins of the cyclones landfalling in different sections of the coast of the Bay. The Bay has been partitioned into 25 sectors (2.50° sectors (2.50° Lat x 2.50° Long) for this purpose. The sectors are numbered by roman numerals. (fig. 2.32)

		Longitude (East)					
		82.5°-85	85-87.5°	87.5°-90°	90°-92.5°	92.5°-95°	95°-97.5°
	17.5°-20°		XXIII	XXIV	XXV		
Longtitude (North)	15°-17.5°	XIX	XX	XXI	XXII		
	12.5°-15°	XIII	XIV	XV	XVI	XVII	XVIII
	10°-12°.5°	VII	VIII	IX	X	XI	XII
	7.5°-10°	I	II	III	IV	V	VI

Table 2.34 gives the number of storms originating in different areas and reaching the different sectors of the coast of the Bay numbered as follows :

1. Sri Lanka 2. Tamil Nadu 3. Andhra Pradesh
4. Orissa/West Bengal 5. Bangla Desh 6. Arakan

The numbers of both are/post monsoon seasons i.e. April-May/ October-December are given in Table 2.34.

Table 2.34

Number of storms originating in different sectors I-XXV of the Bay landfalling in different areas 1-6 of the coast of the Bay. Figures to the left of/are premonsoon (April-May) period; figures and those to the right of/are the post monsoon (October-December) period.

Bay Area	Bay Coast 1	2	3	4	5	6	Total Number of storms	Total Number of storms dissipated in the Bay
I	0/2	0/5	0/0	1/0	0/0	1/0	2/7	2/1
II	0/2	0/5	0/1	0/0	0/1	0/1	0/10	0/1
III	0/1	0/2	0/1	0/2	0/0	0/0	0/6	0/3
IV	0/1	0/1	0/2	0/0	0/1	0/0	0/4	1/2
V	0/0	0/0	0/1	0/0	1/0	0/0	1/1	0/0
VI	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
VII	0/0	1/10	0/5	0/2	0/0	0/0	1/16	1/0
VIII	0/0	1/8	0/5	0/3	0/4	0/1	1/21	0/3
IX	0/0	0/1	1/6	0/2	0/3	3/1	4/13	0/5
X	0/0	0/2	0/1	0/0	1/0	1/1	2/4	0/2
XI	0/0	0/0	0/1	0/0	1/0	1/0	2/1	0/2
XII	0/0	0/0	0/0	0/2	0/0	0/2	0/4	0/0
XIII	0/0	0/1	3/7	0/1	0/1	0/0	5/10	0/4
XIV	0/0	0/1	0/5	0/2	3/3	0/1	3/12	0/5
XV	0/0	0/1	0/2	0/2	2/4	2/0	4/9	0/2
XVI	0/0	0/0	0/1	1/1	0/1	5/0	6/3	2/3
XVII	0/0	0/0	0/3	0/2	1/1	3/1	4/7	2/0
XVIII	0/0	0/0	0/0	0/0	0/1	1/3	1/4	0/0
XIX	0/0	0/0	1/1	0/1	0/1	0/0	1/3	0/2
XX	0/0	0/0	0/1	0/2	2/1	0/0	2/4	0/4
XXI	0/0	0/0	0/2	0/1	0/0	0/0	0/3	0/1
XXII	0/0	0/0	0/0	1/0	4/2	0/1	5/3	1/0
XXIII	0/0	0/0	0/2	3/2	0/1	0/0	3/5	0/2
XXIV	0/0	0/0	0/0	1/6	1/4	0/0	2/10	0/2
XXV	0/0	0/0	0/0	0/0	1/1	2/0	3/1	0/0

It can be seen that a large portion of the storms formed in the Bay do actually landfall. The main points to be noticed from table 2.34 and from more detailed study of storm generation over the Bay are :

1. Premonsoon Season (April-May) : The highest number of storms formed is eight having genesis in Sector XVI. Of these only one reached the Orissa/West Bengal coast, five reached the Arakan coast and two dissipated in the Bay.

2. Postmonsoon season (October-December) : The highest number of storms is twenty four with genesis in sector VIII. Of these eight reached the Tamilnadu coast, five reached the Andhra Pradesh coast, three reached the Orissa/West Bengal coast, four reached the Bangla Desh Coast and one reached the Arakan coast and three dissipated in the Bay.

3. Tamilnadu Coast : In the premonsoon season storms land falling in Tamilnadu are mostly formed in the storms are mostly formed in the area 7-13.5°E.

4. Andhra Pradesh Coast : In the premosoon season storms land falling in Andhra Pradesh are mostly formed in the area 12-16°N and 80-85°E. In the postmonsoon season the scatter of locations of generation of formation of the storms cover a large portion of the Bay.

5. Orissa/West Bengal Coast : For all the seasons the scatter of locations of origin of the storms land falling in Orissa/West Bengal cover a wide portion. The north and central portion of the Bay stand out as the region of storm generation during the June-September period.

Many interesting statistical analysis of the data assessing the changes of cyclone climatology over chosen intervals will be found in this paper.

2.320 A selection of tracks of cyclones visiting Andhra Pradesh and West Bengal : A selection[1] of cyclone tracks in the period 1891-1977 visiting the coasts of Andhra Pradesh and West Bengal has been made and shown in Figures 2.33 - 2.39. The tracks for cyclone visiting Andhra Pradesh during 1891-1977 for September, October, November, December-August are given in Figures 2.33, 2.34, 2.35, 2.36 respectively. The tracks of the cyclones visiting the West Bengal coast

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* Community Cyclone Shelter Construction Programme for Cyclone Prone Coastal Areas of Andhra Pradesh - Revenue Department, Government of Andhra Pradesh (1980) Report of CDMC set up by the Government of West Bengal : Department of Relief and Welfare (Relief Branch)

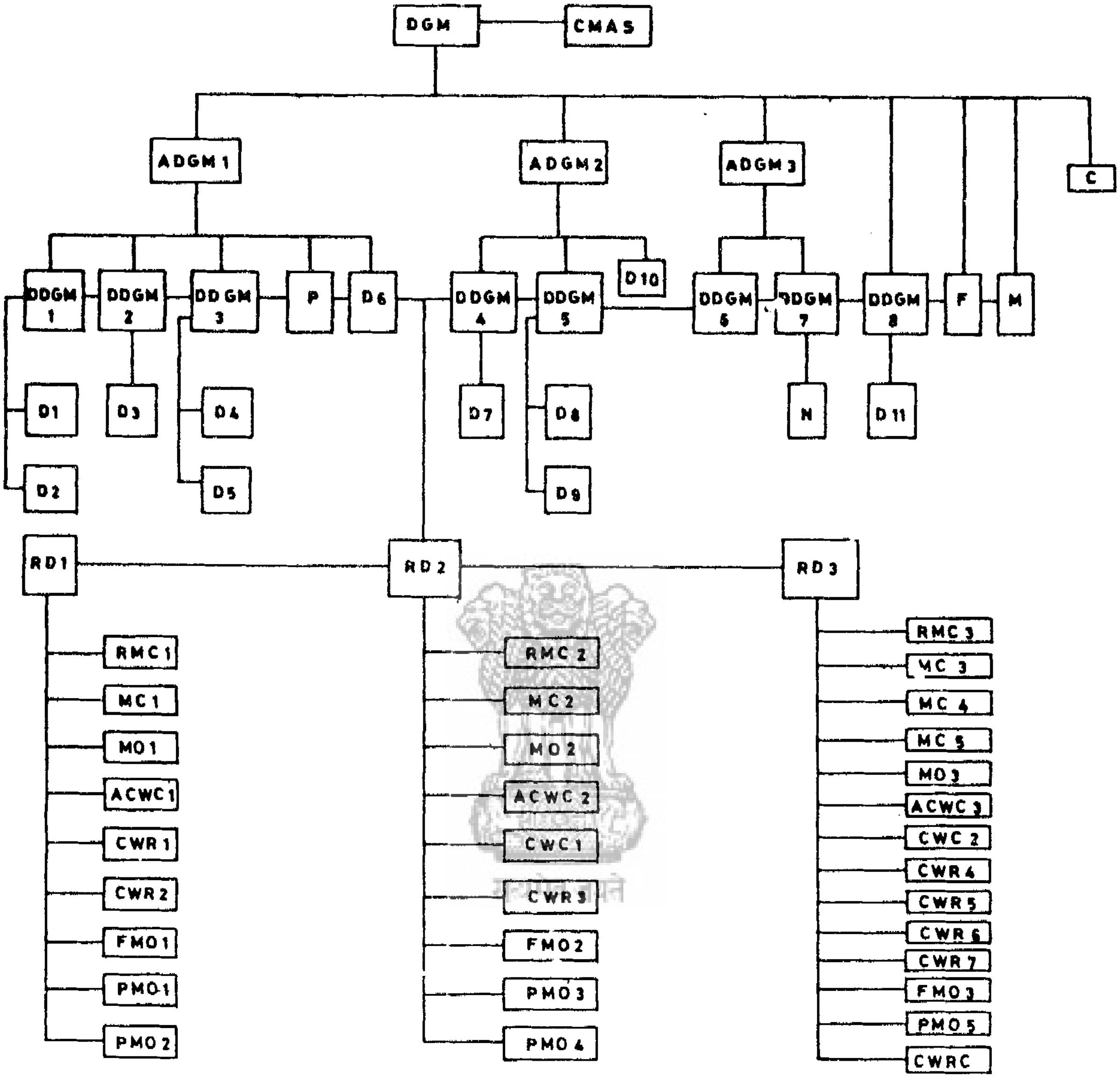

Fig.2.40 The part of the IMD organisation dedicated to cyclones. Reference 2

Legend to Fig.2.40

CMAS : Council of Meteorological and Atmospheric Sciences
DGM : Director General Meteorology
ADGM : Additional Director General Meteorology
ADGM-1 : Instruments - Delhi
ADGM-2 : Services - Delhi
ADGM-3 : Research - Pune
DDGM : Deputy Director General Meteorology
DDGM-1 : Instrument production - Delhi
DDGM-2 : Telecommunication and Instrument development - Delhi
DDGM-3 : Instrument inspection and services - Pune
DDGM-4 : Hydrology - Delhi
DDGM-5 : Weather forecasting - Pune
DDGM-6 : Physical Meteorology and Geophysics - Pune
DDGM-7 : Climatology and Geophysics - Pune
DDGM-8 : Administration and Stores - Delhi
D : Director
D-1 : Radar
D-2 : Radiometeorology
D-3 : Telecommunication
D-4 : Instruments
D-5 : Data Collection Platforms
D-6 : Satellite Meteorology
D-7 : Hydrometeorology
D-8 : Training - Pune
D-9 : Indian Ocean and Southern Hemisphere Analysis Centre
D-10 : Northern Hemisphere Analysis Centre
D-11 : Administration
RD : Regional Director
RD-1 : Bombay
RD-2 : Calcutta
RD-3 : Madras
RMC : Regional Meteorological Centre
RMC-1 : Bombay
RMC-2 : Calcutta
RMC-3 : Madras
MC : Meteorological Centre
MC-1 : Ahmedabad
MC-2 : Bhubaneshwar
MC-3 : Trivandrum
MC-4 : Bangalore
MC-5 : Hyderabad

Legend to Fig.2.40 (continued)

MO : Meteorological Office
MO-1 : Bombay - Airport
MO-2 : Calcutta - Airport
MO-3 : Madras - Airport
ACWC : Area Cyclone Warning Centre
ACWC-1 : Bombay
ACWC-2 : Calcutta
ACWC-3 : Madras
CWC : Cyclone Warning Centre
CWC-1 : Bhubaneshwar
CWC-2 : Visakhapatnam
CWR : Cyclone Warning Radar
CWR-1 : Bombay
CWR-2 : Goa
CWR-3 : Calcutta
CWR-4 : Paradeep
CWR-5 : Madras
CWR-6 : Visakhapatnam
CWR-7 : Karaikal
CWR-8 : Masulipatnam
FMO : Flood Meteorological Office
FMO-1 : Ahmedabad
FMO-2 : Bhubaneshwar
FMO-3 : Asansol
FMO-4 : Hyderabad
PMO : Port Meteorological Office
PMO-1 : Bombay
PMO-2 : Marmagaon
PMO-3 : Calcutta
PMO-4 : Paradeep
PMO-5 : Madras
PMO-6 : Visakhapatnam
PMO-7 : Cochin
CWRC : Cyclone Warning Research Centre - Madras
C : CMAS Secretariate
M : Mausam journal
F : Finance Officer

during 1891-1950 for May is shown in Fig. 2.37, those of cyclones for June in the same period in Fig. 2.38 and those for the same period are shown in Fig. 2.39.

Appendix 2.2 : Organisation of the IMD for cyclone monitoring/ warning.

2.321 Organisational aspect of the IMD : Fig 2.40 gives a bird's eye view of the part of the IMD dedicated to cyclone monitoring/warning. The various units for cyclone monitoring/ warning are shown in the figure together with their position in the hierarchy of the organisation of the IMD.

Appendix 2.3 : Surface Observatories (SOs) in India used for cyclone monitoring.

2.322 Surface Observatories on Coastal India[1] : At the SOs observations are taken on pressure, temperature, humidity, winds, clouds, visibility and rainfall. As mentioned in paragraph 2.29 there are two types of surface observatories DSOs which are departmental observatories of the IMD manned by its own staff and PTSOs which are manned by part time workers borrowed from other organisations. The standard times of observations are 0230, 0530, 0830, 1130, 1430, 1730 2030, 2330 hrs IST. Most of the DSOs take observations at all these times. At the PTSOs observations are taken at 0830 hr during noncyclone season and at 0830 and 1730 hrs IST during noncyclone season. The quality of observations recorded at the PTSOs is deteriorating and attempts are being made to improve the position by increasing the allowance. Many of these PTSOs have been classed as dead or sick. They are being gradually converted into DSOs:- At present there are about 552 SOs of which about 155 are PTSOs. In the coastal states there are about 94 regular SOs at the CPARs of which 49 are DSOs and 45 are PTSOs, Table 2.35 shows the locations of the surface observatories on coastal India upto 1978 when the report of the CDMC was published with some updating. The telcommunication links available at these surface observatories are also given; all the surface observatories also use telegraph offices of the P&T department for despatching the observations.

Table 2.35

Surface Observatories on Coastal India upto 1978

State	Location	Abbre-viation	Type	Eleva-tion (meter)	Telcommunication System TP	TLX	WT
1. Andaman Group	1.Car Nicobar	CNB	PTSO	10	-	-	-
	2.Hut Bay	HTB	PTSO	5	-	-	-
	3.Kondul	KDL	PTSO	8	-	-	-
	4.Long Island	LGI	PTSO	25	-	-	-
	5.Mayabandar	MYB	PTSO	28	-	-	-
	6.Noncowrie	NNC	PTSO	26	-	-	-
	7.Port Blair	PBL	DSO	79	-	-	X
	Total : 7	DSO : 1 PTSO: 6					1

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* IMDCP
IMD Cyclone Manual - Chapter 2
IMD Standard Brief (1983)

State		Location	Abbreviation	Type	Elevation (Meter)	Telecommunication System TP	TLK	WT
2. Andhra Pradesh	1.	Bepatla		DSO	-	-	-	P
	2.	Gannavaram Airport	GNV	DSO	24	P	X	-
	3.	Kakinada	KND	DSO	8	-	-	-
	4.	Kalingapatnam	KLN	DSO	6	-	-	-
	5.	Krishnapatnam	KPT	PTSO	5	-	-	-
	6.	Masulipatnam	MPT	DSO	3	-	-	P
	7.	Nellore	NLR	DSO	20	-	-	X
	8.	Niddavole	-	PTSO	12	-	-	P
	9.	Ongole	ONG	DSO	12	-	-	P
	10.	Vadarevu	VDR	PTSO	4	-	-	-
	11.	Vijawada	-	PTSO	18	-	-	-
	12.	Visakhapatnam Airport	VSK	DSO	3	X	X	X
		Total : 12		DSOs : 8		1	2	3
				PTSOs: 4		1 (P)		5(P)
3. Goa	1.	Daman	DMN	PTSO	12	-	-	-
	2.	Diu	DIU	PTSO	15	-	-	-
	3.	Marmagaon	MMG	DSO	62	-	-	-
	4.	Panjim	PJM	DSO	60	-	-	-
		Total : 4		DSOs : 2		-	-	-
				PTSO : 2				
4. Gujarat	1.	Baroda		DSO	-	-	X	-
	2.	Bhavnagar Airport	BHV	DSO	11	-	X	-
	3.	Bhuj/Rudramata Airport	BHJ	DSO	80	X	-	-
	4.	Broach	BRH	PTSO	17	-	-	-
	5.	Bulsar	BUL	PTSO	-	-	-	-
	6.	Dwarka	DWK	PTSO	11	-	-	-
	7.	Keshod Airport	DSO	DSO	51	-	-	-
	8.	Mahuva	MHV	PTSO	9	-	-	-
	9.	Mandvi	MDV	PTSO	9	-	-	-
	10.	Naliya	NLA	PTSO	21	-	-	-
	11.	New Kandla	KDA	PTSO	14	-	-	-
	12.	Okha	OKH	DSO	7	-	-	-
	13.	Porbandar Airport	PBD	DSO	7	-	-	-
	14.	Surat	SRT	DSO	12	X	X	-
	15.	Veraval	VVL	DSO	8	X	-	-
		Total : 15		DSOs : 8		3	3	-
				PTSOs: 7		-	-	-

State	Location	Abbreviation	Type	Elevation (Meter)	Telcommunication System TP	TLK	WT
5. Karnataka	1. Honavar	HNV	PTSO	26	-	-	-
	2. Karwar	KWR	DSO	4	P	-	-
	3. Mangalore	MNG	PTSO	22	-	-	-
	4. Mangalore/ Bajpe Airport		DSO	102	X	X	-
	5. Shiralo	SRL	PTSO	-	-	-	-
	Total : 5		DSOs : 2		1	1	-
			PTSOs: 3		1(P)	-	-
6. Kerala	1. Alleppey	ALP	PTSO	4	-	-	-
	2. Cannanore	CNR	PTSO	18	-	-	-
	3. Cochin	CHN	DSO	-	-	-	-
	4. Kottayam	KTM	PTSO	-	-	-	-
	5. Kozhikode (Calicut)	CLT	DSO	5	P	-	-
	6. Punalur	-	PTSO	34	-	-	-
	7. Trivandrum	TRV	DSO	64	X	X	X
	8. Trivandrum Airport	-	DSO	8	-	-	-
	Total : 8		DSOs : 4		1	1	1
			PTSO : 4		1(P)	-	-
7. Lakshadwip group	1. Agatty	AGY	PTSO	4	-	-	-
	2. Amindivi	AMN	DSO	4	-	-	-
	3. Androth	ADT	PTSO	5	-	-	-
	4. Minicoy	MNC	DSO	2	-	-	-
	Total : 4		DSOs : 2		-	-	-
			PTSOs: 2				
8. Maharastra	1. Alibagh	ABG	DSO	7	-	-	-
	2. Bombay/Colaba	BMB	DSO	11	-	-	X
	3. Bombay/Santa Cruz Airport		DSO	14	X	X	-
	4. Dahagnu	DHN	DSO	5	P	-	-
	5. Devgarh	DVG	PTSO	36	-	-	-
	6. Harnai	HRN	PTSO	20	-	-	-
	7. Ratbagiri	RTN	DSO		P	-	-
	8. Vengurla	VNG	PTSO	9	-	-	-
	Total : 8		DSOs : 5		1	-	1
			PTSOs: 3		2(P)	-	-
9. Orissa	1. Balasore	BLS	DSO	20	X	-	P
	2. Bhubaneswar Airport	BWN	DSO	46	X	X	X
	3. Chandbali	CBL	PTSO	6	-	-	-
	4. Xurrack	CTK	PTSO		-	-	-
	5. Gopalpur	GPL	DSO	17	-	-	-
	6. Paradip-CWR	PRD	DSO	8	X	-	X
	7. Puri	PRI	DSO	6	-	-	P
	Total : 7		DSOs	5	3	1	3
			PTSOs	2	-	-	2(P)

State	Location	Abbre-viation	Type	Eleva-tion	Telecommunication		
					TP	TLX	WT
10. Pondicherry							
	1. Karaikal	KKL	DSO	7	-	-	-
	2. Pondicherry	PDC	PTSO	6	-	-	-
	3. Porto Novo	PON	PTSO	3	-	-	-
	Total : 3		DSO - 1		-	-	-
			PTSO- 2		-	-	-
11. Tamil Nadu							
	1. Adirampattinam	ARP	PTSO	6	-	-	-
	2. Cuddalore	CDL	DSO	12	-	-	X
	3. Kallakurchi		PTSO	127	-	-	-
	4. Kanniyakumari	KYK		37	-	-	-
	5. Madras/Minan bakkam ACWC		DSO	16	X	X	X
	6. Madras/Nungam bakkam ACWC	MDS	DSO	6	X	X	-
	7. Nagapattinam	NPT	DSO	9	-	-	-
	8. Palayankottai	-	PTSO	51	-	-	-
	9. Pamban	PBN	DSO	11	P	-	-
	10. Tondi	TND	DSO	5	-	-	P
	11. Tutticorin	TTC	PTSO	4	-	-	-
	12. Valinokkam	-	PTSO	-	-	-	-
	13. Vedaranniyam	VRM	PTSO	-	-	-	-
	Total : 13		DSOs : 7		2	2	2
			PTSOs: 6		1(P)	-	1(P)
12. West Bengal							
	1. Calcutta/Alipore	CAL	DSO	6	X	X	-
	2. Calcutta/Dumdum Airport		DSO	6	X	X	X
	3. Contai	CNT	PTSO	11	-	-	-
	4. Diamond Harbour		DSO		-	-	-
	5. Digha				-	-	-
	6. Haldia		DSO		-	-	-
	7. Midnapore		PTSO	45	-	-	-
	8. Sagar Island		PTSO	11	-	-	-
	9. Sandheads	SDH	PTSO	10	-	-	X
	Total : 8		DSOs : 4		2	2	3
			PTSOs : 5		-	-	-

2.323 Cooperative Cyclone Reporting Network (CORN)[1] : After the CDMC report was published a close density network of surface observatories was etablished in the states on the east coast which came to be known as the Cooperative Cyclone Reporting Network of Stations (CCRN). Table 2.36 shows the locations of these surface observatories as established and Table 2.37 shows the location

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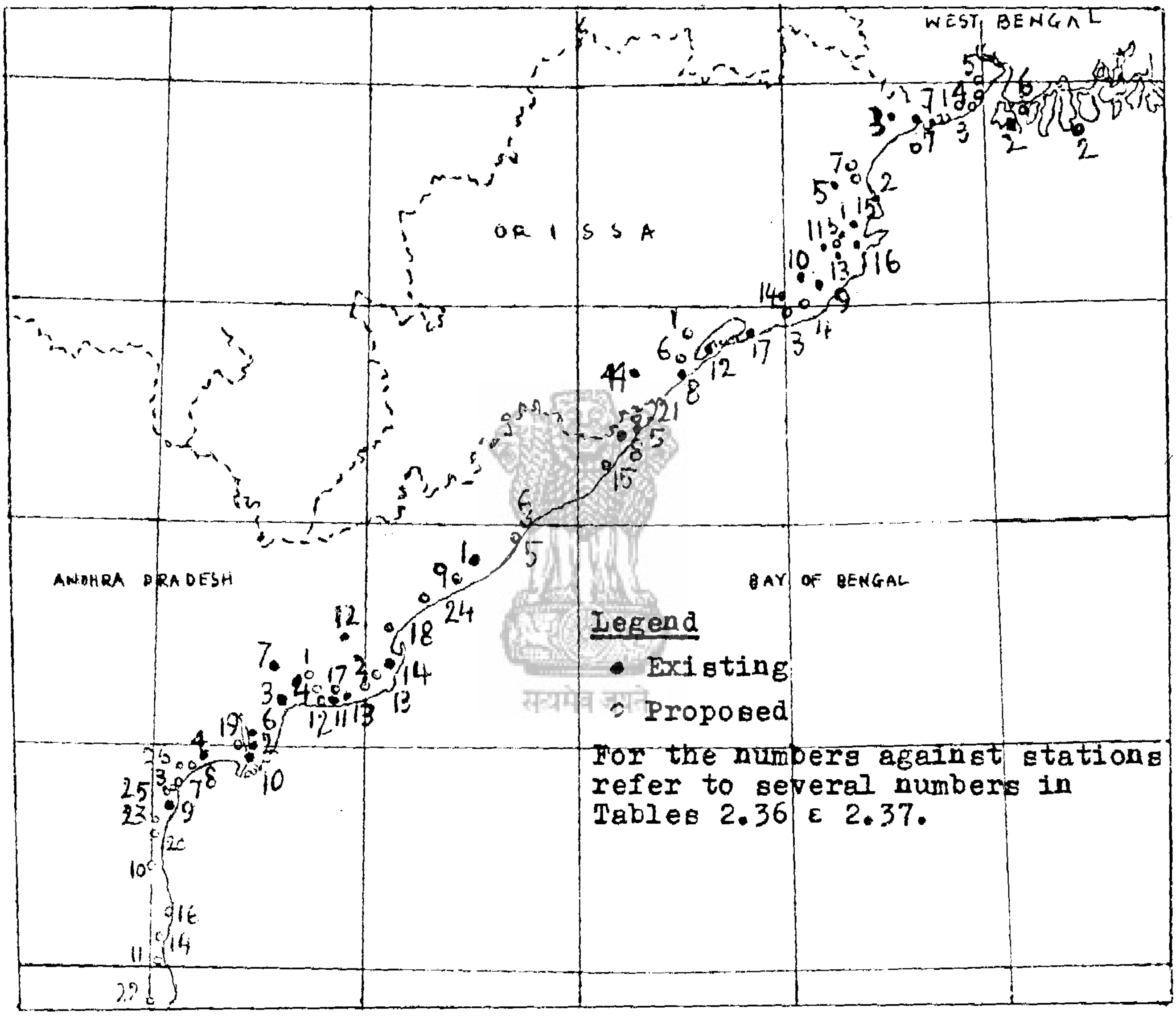
* IMD Cyclone Manual - Chapter 2



Legend

● Existing

○ Proposed

For the numbers against stations refer to several numbers in Tables 2.36 & 2.37.

Fig. 2.42 : The Cooperative Cyclone Reporting Network (CCRN) of the IMD. Reference 39

of proposed additional stations in this network. These are all of the PTSO type, taking observations of wind and rainfall only at 0830 hr IST during noncyclonic seasons and at 0830 and 1730 hrs IST during cyclone seasons. The only way of despatching the data from the CCRN stations is by the telegraph offices of the P&T Department. As observed already in paragraph 2.29 the part time workers are not dependable about the care that must be taken in taking the observations. Furthermore during cyclone emergencies these workers can not be expected to stand by like Casabianca defying the fury of the cyclones. These stations are likely to be abandoned by their workers whose primary concern would naturally be about their own safety. Thus the experience has been that the data from the PTSOs have been generally erratic and incoherent, being therefore unreliable for the purpose of cyclone assessment. There is a strong case for converting such PTSOs to autonomous telecasting DCPs and the Committee has made recommendations in this respect (Recommendation CRC/11 & 18)

Table 2.36

Cooperative Cyclone Reporting Network stations established after 1978

State	Location	Telegraph Office	Distance
1. Andhra Pradesh	1. Anakapalli	Anakapalli	1500
	@. Avinagadda	Avinagadda	200
	3. Bantimalli	Bantimalli	1000
	4. Baruva	Baruva	200
	5. Challapalli	Challapalli	500
	6. Eluru	Eluru	1000
	7. Kasibugga	Kasibugga	200
	8. Kothapatnam	Kothapatnam	200
	9. Nagayalanka	Nagayalanka	1000
	10. Narasapuram	Mypand	500
	11. Rajamundry	Rajamundry	2500
	12. Razole	Razole	200
	13. Yanam	Yanam	1000
	Total 13		
2. Orissa	1. Aul	Aul	2000
	2. Bansara	Bansara	2000
	3. Basta	Basta	1000
	4. Berhampur	Berhampur	3000
	5. Bhadrak	Bhadrak	2000
	6. Bhograi	Bhograi	2000
	7. Brahmagiri	Brahmagiri	1000
	8. Chhatrapur	Chhatrapur	500
	9. Ersama	Ersama	2000

State	Location	Telegraph Office	Distance (meter)
	10. Jagatsingpur	Jagatsingpur	1000
	11. Kendrapara	Kendrapara	2000
	12. Krishnaprasad	Krishnaparasad	500
	13. Mahakalpara	Mahakalpara	2000
	14. Nimpara	Nimpara	500
	15. Rajkanika	Rajkanika	2000
	16. Rajnagar	Rajnagar	1000
	Total : 6		
3. West Bengal	1. Frasergunj		

Table 2.37

Proposed additions to Cooperative Cyclone Reporting Network Stations

State	Location
1. Andhra Pradesh	1. Akivido, 2.Amalapuram, 3. Ammonabralu 4. Bhimavaram, 5.Bhimunipatnam, 6. Bhogapuram, 7. Chinaganjam, 8. Chirala, 9.Elamanchili, 10. Kavali, 11.Kota, 12. Mogattur, 13.Mummudivaram, 14.Muttukuru, Navapada, 16.Palakollu, 17.Pithapuram, 18. Repalle, 19.Sigarayakonda, 20. Somepeta, 21. Sulurpeta, 22.Tunguturu, 23. Tuni, 24. Uppugundura, 25.Vetapalam
	Total : 25
2. Orissa	1.Banpur, 2.Basudevpur, 3.Gop, 4.Kakatpur 5.Patamundai, 6.Rambha, 7.Sona
	Total : 7
3. West Bengal	1. Dalhousie Point, 2. Dariapur, 3.Khijuri, 4. Nandigram, 5.Pathar Pratim, 6. Ramnagar
	Total : 6

2.324 Instrumentation for the Sos[1] : Development and testing of the instruments used at the SOs are done mainly at the laboratories at New Delhi and Pune of the IMD. The workshops are now able to meet the development's normal

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* CMAS Meetings : Notes on Agenda

requirements. All types of surface observation instruments like simple anemometers and wind vanes are made in the workshops. A project has been approved for the development of automatic high speed wind recorders at coastal observatories. The Committee has recommended development of wind measuring instruments capable of standing upto cyclone (CRC/8). The Research & Development group at Pune is responsible for 1) design/development of improved meteorlogical sensors for ground based observations over land/sea 2) design/development of electronics and other auxilliary instruments/packages for semi/full automation of meteorological data from SOs/fixed unmanned stations on land/sea,3) design/development of suitable equipment for remote sensing/quick dissemination of airport data to reach the MOs.

2.325 TC links available at the SOs[1]: It has been stressed that the SOs should be connected at the Data Collection Centres/various meteorological centres/ACWC/CWCs by cyclone proof TCCs like WT/RTT. From table 2.35 it can be seen that very few of the SOs are thus equipped. It has been proposed to improve the TC channels as shown in table .38.

Table 2.38

Proposal for strengthening of TCCs at the Coastal States

Pune	WT	RCC-Bhubaneswar
Pune	WT	RCC-Calcutta
RCC Madras	WT	1. Kalingapatnam 2. Ongole 3. Bapatla 4. Tondi
RCC - Bombay	TP	1. Pamban 2. Vellore 3. Salem
RCC - Bombay	WT	1. Ratnagiri 2. Dahanu 3. Pune
RCC - Bangalore	TP	1. Bilgaum 2. Karwar
RCC - Hyderabad	TP	1. Kurnoal 2. Gannayaram
RCC - Trivandarum	TP	Calicut

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* CMAS Meetings : Notes on Agenda

It is proposed to increase the number of TP/WT/TLX circuits at the various RMCs.

2.326 Surface Observatories on the coasts of neighbouring countries:[2]

Table 2.39 gives the surface observatories in neighbouring countries.

Table 2.39

Surface observatories on the coasts of neighbouring countries

Country	Location
1. Bangla Desh	1.Chittagong/Patenga(6), 2.Cox's Bazar (4), 3.Khepupara (9)
2. Burma	1.Akyab(5), 3. Bassein(10) 3.Coco Islands(3) 4.Kyaukpyu(5), 5.Merqui(37), 6.Rangoon(23), 7.Sandoway(11),8.Tavoy(17),9.Victoria Point(47)
3. Pakistan	1.Jiwani(56),2.Karachi Airport(22),3.Ormara(5), 4.Pasani (9)
4. Sri Lanka	1.Batticaloa(12),2.Colombo(6),3.Hambantota(20) 4.Jaffna(3),5.Kanakesenturai(15),6.Manner(3) 7.Puttalam(2), 8. Trincomalee(7).

Legend:Figures in bracket indicate elevation from sea level in meters

Appendix 2.4 : Upper Air Observatories (UAOs) in India used for cyclone monitoring

2.327 Upper Air Observatories (UAOs) on coastal India[1] :

As mentioned in paragraph 2.31, these observatories are of four types:

RSO/RWO : with both Radiosonde and Radiowind facilities

RSO : with Radiosonde facility only

RWO : with Radiowind facility only

PIBAL : with Pilot Baloon facility only

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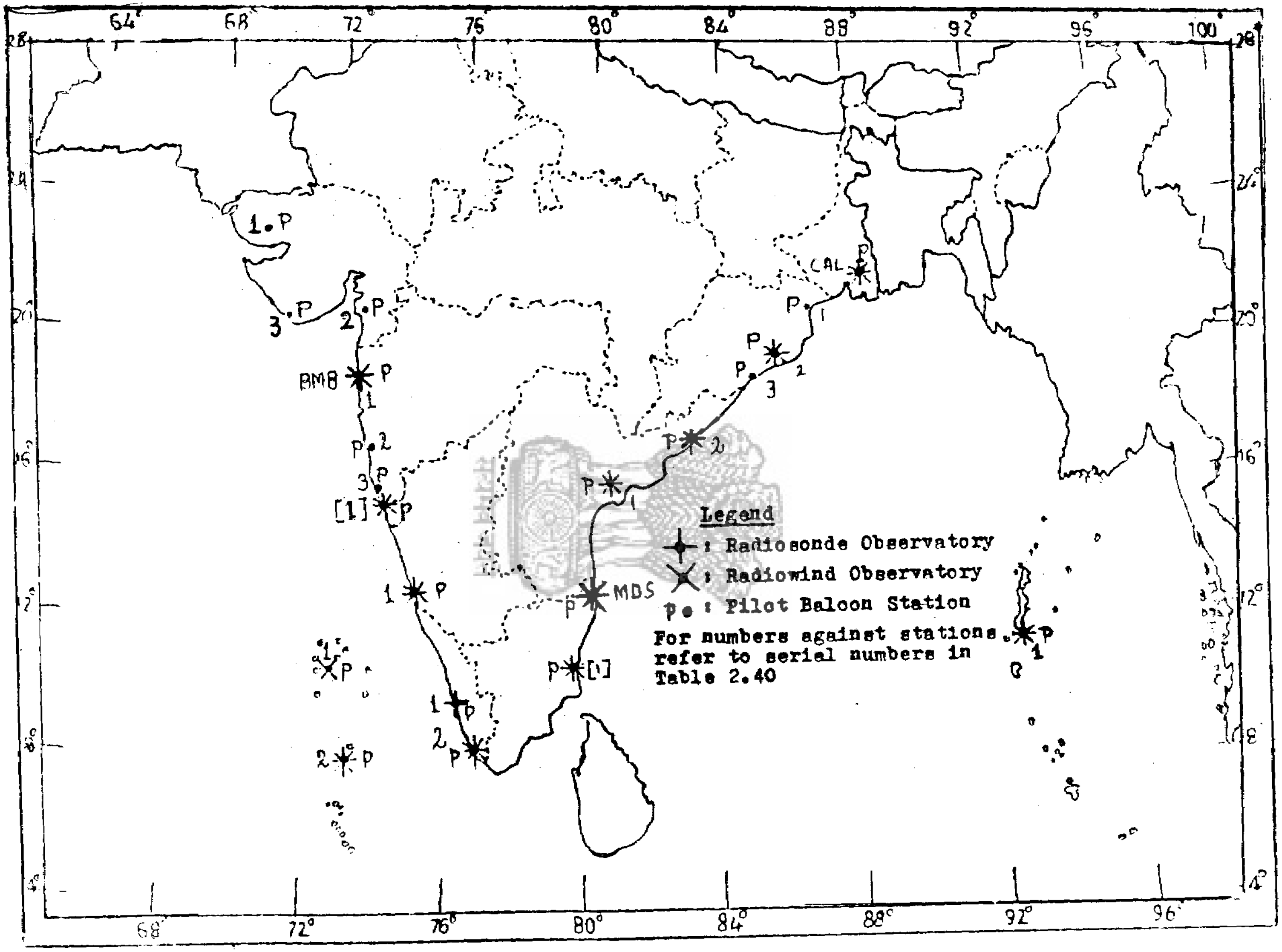

Fig.2.43 The location of the Upper Air Observatories (UAOs) on coastal India. Reference 39 and Table 2.40

The normal times of ascents are 0530, 1130, 1730 and 2330 hrs. IST. Table 2.40 shows the locations of the different types of Upper Air Observatories on coastal India. It is seen that the number of Upper Air Observatories on coastal India in very unadequate considering the very large length of the coast line to be covered.

Table 2.40

Upper Air Observatories (UAOs) on coastal India

State	Location	Abbre-	Type of UAO		
			RSO	RWO	PIBAL
1. Andaman Group	1.Port Blair	PBL	1	1	1
	Total : 1	Total	1	1	1
2. Andhra Pradesh	1.Vijayawada/ Gannavaram	GNV	1	1	1
	2.Visakhapatnam/ Waltair	VSK	1	1	1
	Total : 2	Total	2	2	2
3. Goa	1.Panjim	PJM	1	1	1
	Total : 1	Total	1	1	1
4. Gujarat	1.Bhuj/Rudramata Airport	BHJ	-	-	1
	2.Surat	SRT	-	-	1
	3.Veraval	VVL	-	-	1
	Total : 3	Total	-	-	3
5. Karnataka	1.Mangalore/Panambur	MNG	1	1	1
	Total : 1	Total	1	1	1
6. Kerala	1.Cochin/Ernakulam	CHN	1	-	1
	2.Trivandrum	TRV	1	1	1
			2	1	2
7. Lakshadwip Group	1.Aminidivi	AMN	-	1	1
	2.Minicoy	MNC	1	1	1
	Total : 2	Total	1	2	2
8. Maharashtra	1.Bombay/Santa Cruz Airport	BMB	1	1	1
	2.Ratnagiri	RTN	-	-	1
	2.Vengukla	VNG	-	-	1
	Total : 3	Total	1	1	3

State	Location	Abbre-	Type of UAO RSO	RWO	PIBAL
9. Orissa	1.Balasore	BLS	-	-	1
	2.Bhubaneswar Airport	BWN	1	1	1
	3.Gopalpur	GPL	-	-	1
	Total : 3		1	1	3
10. Pondicherry	1.Karaikal	KKL	1	1	1
	Total : 1	Total	1	1	1
11. Tamil Nadu	1.Madras/ Minambakkam	MDS	1	1	1
	Total : 1		1	1	1
12. West Bengal	1.Calcutta/Dumdum Airport	CAL	1	1	1
	Total : 1	Total	1	1	1

Appendix 2.5 : Automatic Data Collection Platforms (DCPs) used for cyclone monitoring

2.328 Proposed locations of the DCPs in the coastal states[1] of India :

The location of the CCPs is still tentative. It is contemplated that 100 DCPs will be located on the Indian soil and 10 on seas in three phases. The first DCP under the INSAT programme has already been installed at the Master Control Facility at Hasan where a prototype unit of Data Collection Storage and Transmission System (DCSTS) has been installed. Table 2.41 gives the possible location of the DCPs in the coastal states and the island groups.

Table 2.41

Proposed locations of DCPs in coastal states and Island groups

State	Location
1. Andhra Pradesh	1.Annavaram,2.Antarvedi,3.Baruva,4.Bhimunipatnam, 5.Elamanchili, 6.Ichchpuram, 7.Kavali,8.Krishnapatnam, 9.Narasapuram, 10.Mizampatnam, 11.Razole, 12.Sulurpeta, 13.Tuni, 14. Vadarevu
	Total : 14

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* Informations provided by Dr. U.V. Gopala Rao of the IMD.

	State	Location
2.	Gujarat	1.Ahmedabad,2.Alibet,3.Dwarka, 4.Jafarbad 5.Jakhau, 6.Koteswar, 7.Mahuva, 8.Miyami 9.Mandvi, 10.Navalakhi, 11. Taleja 12. Umbergaon
		Total : 12
3.	Karnataka	1.Bangalore, 2.Bhatkal, 3. Coondapur, 4.Hasaan, 5.Karwar, 6.Upidi
		Total : 6
4.	Kerala	1.Alleppey,2.Cannanore, 3.Chavakad, 4.Hosdurg,5.Kasargod, 6.Ponnani, 7.Quilandi, 8.Quilon
		Total : 8
5.	Maharashtra	1.Bombay, 2.Dindori, 3.Dhond, 4.Edelabad, 5.Harnai, 6.Janjira, 7.Jaygad, 8,Malvan, 9.Murud, 10.Pune, 11.Vijaydurg
		Total : 11
6.	Orissa	1.Balipal, 2.Basudevpur, 3.Bonaigarh, 4.Chhatrapur, 5.Chandbali, 6.Chandipur, 7.Konarak, 8.Krishnaprasad, 9.Rambha, 10. Sonepur
		Total : 10
7.	Pondicherry	1.Pondicherry
		Total : 1
8.	Tamil Nadu	1.Adirampattinam, 2.Chidambaram, 3.Madras 4.Mahabalipuram, 5.Pulicat, 6.Sayalkudi, 7,Tiruchendur, 8. Vedarananiyam
		Total : 8
9.	West Bengal	1.Bakkhali, 2.Calcutta, 3.Canning, 4.Dariapore, 5. Gosaba, 6.Junput, 7. Raidighi
		Total : 7

Appendix 2.6 : Radar used for cyclone monitoring and weather watching

2.329 Weather radars on Indian coast[1] :

There are a number of X-band Weather radars installed on the Indian coast which may be used as standbys in case of failures of the regular S band radars. There are generally installed in airports and need urgent replacement Table 2.42 gives the locations of these X-band radars.

Table 2.42

Weather radars on Indian coast

	State	Location	Remarks
1.	Andhra Pradesh	Visakhapatnam	Salenia wind finding radar
2.	Goa	Goa	Salenia wind finding radar
3.	Karnataka	1,Bangalore Airport 2.Mangalore	Salenia wind finding radar
4.	Kerala	Trivandrum	Salenia wind finding radar
5.	Maharashtra	Bombay-Santa Cruz Airport	Weather radar
6.	Orissa	Bhubaneswar	Salenia wind finding radar
7.	Tamil Nadu	Madras - Airport	Salenia wind finding radar
8.	West Bengal	Calcutta-Dumdum Airport	Weather radar

2.330 Cyclone adar stations in neighbouring countries[2] :

Table 2.43 shows the CWRs in the neighbouring countries and their present status.

Table 2.43

	Country	Location	Status
1.	Bangladesh	1. Cox's Bazar	Functioning
		2. Dacca	Functioning
		3. Khepupara	Functioning
2.	Burma	1. Kyaukpyu	Functioning
		2. Rangoon	Proposed
3.	Pakistan	1. Karachi	Functioning
		2. Jiwani	Proposed
4.	Sri Lanka	1. Trincomalees	Proposed

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Since the communications with the neighbouring countries on meteorological matters are through the Global Telecommunication Service (GTS) terminal at RTH-Delhi, radar informations on cyclones in the Arabian Sea and the Bay of Bengal can very rarely be obtained on real time.

2.331 Doppler Radar[1] :

Accurate knowledge of wind-field inside a severe storm is very necessary in order to estimate the severity of the cyclone. Conventional weather radars, though ideally suited for locating and studying the pattern and movement of cyclones, are not capable of providing information on wind-fields inside a storm. For observing air motions within storms, Doppler radar techniques have been attempted in Japan and U.S.A. Both pulsed and Continuous Wave (CW) Doppler radars have been tried. While CW Doppler radar cannot give range information, only the pulsed doppler radar can give because it is a coherent radar which means that it can measure the phase difference between transmitted and received signals. Analysis of the data provided by a single Doppler radar relies heavily on statistical assumptions regarding motion of hydrometeors because of the absence of adequate knowledge of vectorial velocities of hydrometeors in the storm. The use of the Doppler radars, installed at different locations and simultaneously observing the same storm, improves the capability of the Doppler method since the horizontal motion field of hydrometeors inside the convective cells can be mapped out. But in order to provide a complete knowledge of the three-dimensional field of the three components of the motion of hydrometeors in the storm, it appears necessary to employ three Doppler radars installed at three different locations and simultaneously observe the same storm. This type of mutti-Doppler techniques are prohibitive in cost. Therefore attempts have been made to derive wind information from a single Doppler radar equipped with special processors and digital computers. The development is recent because it had to wait till the development and availability of very fast digital computer techniques and special processors for processing and interpreting the Doppler radar data. It is now possible in principle, if cost is not a consideration, have colour coded display of storm reflectivities, mean radial velocities and their variance, with the help of special displays developed specifically for Doppler studies.

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[*] Radar design for determining the strength of tropical cyclones in the Bay of Bengal - Marc Report No.6, prepared by Monitoring and Assessment Research Centre of the Sceintific Committee on Problems of Environment, International council of scientific unions with the support of United National Environment Programme and the Rockefeller Foundation. Notes in paragraphs 2.331-2.333 have been prepared by Dr. D.K. Rakshit Member of this Committee.

2.332 Limitations of Doppler radar:

In the Doppler radar technique, there are a few contradictions which force a compromise in technical specifications. The most important of these relate to measurements of range and velocities unambiguously. If high velocities normally experienced in cyclones are to be measured unambiguously, long wavelength and high Pulse Repeatition Frequencies (PRF) should be used. On the other hand, for long ranges, the PRF should have a lower value. Both these are conflicting requirements. If conventional Doppler techniques are employed, it is necessary to compromise between v_{max} and r_{max} if these are to be measured at the same time with the same instrument. For r_{max} of 300 km, a PRF of 500 is necessary which will give an unambiguous velocity of ± 13.38 m/sec only. For v_{max} of 100 m/sec at 10 cm wavelength. PRF should be 4000 which would give an unambiguous range of only 37.5 km. As a compromise, a workable set of specifications would involve an S-band (10 cm) radar with 1^{o} beam with a range 300 km and PRF value of 500. This would enable study of winds upto a height of 6 km above ground and indicate maximum unambiguous velocity of 13.4 m/sec.

2.333 Points for consideration for decesion about acquiation of a Doppler radar facility for India :

The following points have, however, to be considered carefully before taking decisions in the matter of procuring a Doppler radar for the country:

1. Doppler radar with its advanced digital processing techniques is a highly complex system. Utilization and interpretation of data from such a system will need a highly skilled and well trained team of engineers and scientists to work in close collaboration.

2. Since the Doppler radar requires about one degree conical beam width at S-band, the antenna diameter would be more than 7.7 metres and with an adequately large radome; such an installation will need special strong structures. It will not be possible to instal them on any of the existing structures The installation necessary for a Doppler radar will therefore, have to be planned de-novo. The problem of likely interference from the existing S-band conventional radars will also have to be carefully solved

3. The initial costs on capital equipment, accessories, test equipment, spares, and capital works would amount to about Rs. 2 Crores at each site. The entire capital equipment cost (about Rs. 1.5 crore) would be in foreign exchange.

4. At present Doppler radars are not available commercially. So far, development of Doppler radar techniques has been limited to research laboratories in Japan U.K. and USA.

Appendix 2.7 Satellite monitoring of cyclones[1]

2.334 Satellite communication ground segment:

Table 2.44 gives the satellite communication ground segments which are already established in India or are being proposed under the INSAT programmes. It is unfortunate that INSAT-1A stopped sending VHRR imageries from April 13, 1982. The INSAT-1B has been operational since

Table 2.44

Satellite	Terminal Type	Locations	Capability/Purpose
1.Polar orbitting Tiros-N NOAA-6	Existing APT receiving terminals	1.NHAC-New Delhi 2.WC-Pune 3.ACWC-Bombay 4.ACWC-Calcutta 5.ACWC-Madras 6.CWC-Bhubaneswar 7.CWC-Visakhapatnam 8.MO-Gauhati	Automatic receiving/transmission of low resolution pictures
	VHRR picture receiving terminals	1.NRSA-Hyderabad 2.SAC-Ahmedabad 3.NHAC-New Delhi	Receiving/transmission of VHRR cloud imagery
2.INSAT-1B,C	(a) Master control facility (MCF)	Hassan(Karnataka)	Orbit control, raising and management of satellites. Health monitoring of satellites
	(b) Network operation Control Centre (NOCC)	Delhi-Secunderabad (Uttar Pradesh)	For coordination and control and utilisation of all the earth centres.
	(c) Satellite Control/Twin Satellite Operation Earth Stations (TSOES)	1.Bombay 2.Calcutta 3.Delhi-Secunderabad (DES) 4.Hassan 5.Madras	

Information provided by Dr. U.V. Gopala Rao of the IMD.

Satellite	Terminal Type	Locations	Capability/Purpose
	(d) Large Earth Stations (LES)	1.Shillong 2.Urban	31.7 db/°K. Intermain and main primary trunk telephony. Remote and communication, TV uplink for feeding TV channels, Reception of meteorological data from TSOES-Delhi
	(e) Medium Earth Station (MES)	1.Ahmedabad 2.Aizwal(Mizoram) 3.Bhubaneswar 4.Car Nicobar (Andam Group) 5.Two on Bombay High(offshore) 6.Ernekulam(Kerala) 7.Jaipur(Rajasthan) 8.Jullunder(Punjab) 9.Kavarathi Islands (Lakshadwip) 10.Leh 11.Lucknow(Uttar Pradesh) 12.Patna(Bihar) 13.Port Blair (Andaman)	25.7 db/°K Trunk telephony (main primary) TV uplink feed
	(f) Small Earth Station - Remote Area Terminal (RAT)	1.Agartala(Tripura) 2.Bhuj 3.Gangtok(Bhutan) 4.Goa 5.Imphal(Manipur) 6.Itanagar(Arunachal (Pradesh) 7.Jodhpur(Rajasthan) 8.Kohima(Nagaland) 9.Minicoy(Lakshadwip) group) 10.Srinagar(Kashmir)	19.7 db/°K. Telephony only
	(g) Transportable	1.Four road transportable terminal	19.7 db/°K.Telephony TVuplink feed
		2.Two jeep transportable/airliftable emergency communication terminals	19.7 db/°K or 17.5 db/°K

Satellite	Terminal Type	Locations	Capability/Purpose
	(h) Meteorological Data Utilisation Centre (MDUC)	Delhi	Processing INSAT VHRR/ DCP data received at Delhi Earth Station (DES) on real time and transmitted to MDUC-New Delhi by microwave link
	(i) Secondary Data Utilisation Centre (SDUC)	1. WC-Pune 2. ACWC-Bombay 3. ACWC-Calcutta 4. ACWC-Madras 5. VWV-Bhubaneswar 6. CWC-Vishakhapatnam 7. RCC-Nagpur (Maharashtra) 8. SSC-Ahmedabad (Gujarat) 9. SCC-Bhopal (Madhya Pradesh) 10. SCC-Gauhati (Assam) 11. SCC-Lucknow (Uttar Pradesh) 12. SCC-Patna (Bihar) 13. SCC-Srinagar (Kashmir) 14. SCC-Trivandrum (Kerala) 15. MO-Hyderabad (Andhra Pradesh) 16. MO-Jaipur (Rajasthan) 17. Airport-Bombay 18. Airport-Calcutta 19. Airport-Madras 30. Airport-Delhi	There are generally located at the various forecast centres of the IMD. Will receive processed images from MDUC-Delhi over TC lines including INSAT circuits

Appendix 2.8 : Cyclone probing aircrafts (CPAs)[1]

2.335 Instrumentation on board cyclone probing aircrafts (CPAs):

A general list of the onboard instruments on CPAs for meteorological parameters and physics has been given in Recommendation CRC/32. Table 2.45 gives some details about the capabilities necessary for these instruments and some systems navigation.

Table 2.45

Instrumentation for Cyclone Probing Aircrafts (CPAs)

Measurement Objectives	Measuring Range	Measuring Accuracy	Suitable Instrument
I. Meteorological Parameters			
1. Total/free air temperature	-90°C to +50°C	±0.5°C	Rosemount ventilated resistance thermometer
2. Atmospheric Pressure - static	150 to 1060 mb	±0.325 mb	Kollsman, Garrett variable capacitor Analog/digital
3. Atmospheric pressure			-do-
4. Pilot head			
5. Flight level winds	4-300 kt	4-5 kt	Northrop or Litton Marconi Omega - INS (computed from RAS, G.S. and Drift angle) or dual Carousal IN system Delca Electronics
6. Dew Point	-50°C to +50°C	±1°C	Cambridge Dew point optical and mirrored surface
7. Sea surface temperature	-50°C to 50°C	±1°C	Barnes Type PRT-5
8. Wind		1m/sec (4min average)	Tractor Corporation Omega dropsonde.
Temperature	-50°C to +30°C	±0.5°C	
Humidity	10 to 100% RH		
	150 - 1060 mb	±2mb	

Measurement Objectives	Measuring Range	Measuring Accuracy	Suitable Instrument
9. Radar Altitude	0-1500M		Steward Warner Electronics Model AN/ APN-159 or Make:TRT France
II. Cloud Physics			
1. Cloud liquid water	0-10 gm/m^3	10% of actual	Bacherach Instrument Johnson-William heated wire
2. Total liquid water	-do-	-do-	Merceret-Schrider
3. Hydrometeor size spectrum (cloud droplet/hydrometeor	280/ to 300/ drop radius	Number:5% Radius:10%	Particle measuring system-Knollenberg Probes
III. On board Photography System			
1. Sea state photography (looking down)	1 frame/5 sec		35 mm Cameras Teledyne Camera systems complete with lens (modified to include relation pulse generator)
2. Time lapse cloud photography (side looking)	-do-		
3. Data panel photography	-do-		
4. Radarscope photography recording	Variable		
IV. Navigational parameters			
1. Latitude			Inertial Navigational & Omega system LORAN system
2. Longitude			
3. Absolute position			
4. Ground Speed			
5. Distance traversed			
6. Drift angle			

2.336 The CPA onboard data recording system:

It is desirable to have two separate recording systems abroad the CPAs

1) One system dedicated to the meteorological cloud physics/radiation sensor/and IN system

2) The other system dedicated to the nose/lower fuselage (belly) radar. The recording should be done in two formats. In the digital format the rate should be one/sec whereas for the analog format the rate may be higher. Filtered data should be further processed to calculate flight level/meteorological parameters/displayed CRTs at all positions of the aircraft for quick look and also for manual logging. The storage of the radar data should be acomplished simultaneously via two ways.

a) data stored by a digital magnetic tape recorder

b) data stored by a video analog tape recorder

so that the recorded data may be viewed on real time or played back. The digital recording minicomputer data system onboard should include 400 Hz power converter, digital clocks, peripherals and all necessary soft/hard wares.

2.337 Radars necessary on CPAs :

It has been mentioned in paragraph 2.73 two radars are usually needed aboard CPAs - a belly fan beam radar with 360° and a nose conical radar with 240°. Table 2.46 gives some details about the specifications/functions of these radars. These radars are purely for meteorological observation and there are in addition to the C-Band Weather radar (nose type RCA - AVO 30) which is used for navigation.

Table 2.46

Specifications of meteorological radars aboard CPA

	Radar	Description	Specification	Instrument Maker
1.	Belly	C-Band PPI 360° scan horizontal fan beam radar	1.Frequency:5370+6.7MHz 2.Pulse Length :6 sec 3.PRF :200 4.P_t :70 KW(Magnetron) 5.Receiver : Log 6.Receiver dynamic range 6 db	Radio Corporation of America (RCA)

Radar	Description	Specification		Instrument Maker
		7.Receiver band width	233 KHz	
		8.IF	30 MHz	
		9.Antenna polarisation	Lin, Horizontal	
		.0.Gain-main beam	37 db	
		11.Beam width	Hor 1.1° Ver 4.5°	
		12.Side lobe gain	23 db down	
		13.Average Coverage	360°	
		14.Ele Coverage	20°	
		15.Antenna Stabilisation	Pitch/Roll	
II.Nose	C-Band PPI 240° scan conical	Specification would be such as not to interfere with the belly radar		RCA

2.338 The Choice of CPAs:

The basic criteria for choosing an aircraft for probing cyclones has been given in paragraph 2.73. Table 2.47 gives the capabilities of the various aircrafts used for aircraft probing of cyclones (APC) for comparison. The Research Facility Centre (RFC) at International Airport Miami uses only one WC-130B-Hercules and two WP-3D-Orion aircrafts.

Table 2.47

Description of Operation Capabilities of Research Aircrafts capable of cyclone probing

	DC-6 (Douglas Aircraft)	B-57 (Martin)	WC-130B (Hercules)	WP-3D Orion Prodata 1974
1.Wing span	117.6	64	132.7"	99.7"
2.Fuselage length	106.6	65.6	97.9"	144.3"
3,Maximum height	28.8	15.7	38.6"	33.8"
4.Wing dihedral	7°	-	-	-
5.Maximum gross weight	107,000 lb	48,000 lb	135,000 lb	135,000 lb
6.Maximum landing weight	88,200 lb	No restriction	-	-
7.Maximum Zero fuel	83,200 lb	-	-	-
8.Empty weight of Aircraft	72,500 lb	-	-	-

	DC-6 (Douglas Aircraft)	B-57 (Martin)	WC-130B Hercules Prodata 1958	WP-3D Prodata 1974
9. Operational Crew	4+7(Scientists etc.)	2	4+7(Mission -minimum)	4+7(Mission minimum)
10. Air speeds	248kt(sea level to 17000 ft)	≃400 Kt	280 kt	325 kt
11. Maximum altitude	25,000 ft. (Pr altitude)	40,000 ft (Pr altitude)	30,000 ft (Op altitude)	30,000 ft (Op altitude)
12. Icing conditions	Limited to Operations in icing conditions	No anti-icing available	No restriction	No restriction
13. Structural limits	2.5G(flap up)	5.0G(without wingtip tanks)	-	-
14. Maximum edurance (at 1500 ft)	14 hrs	4 hrs	9 hrs(en-route time at 20,000 ft.)	10 hrs (en-time at 20,000 ft.)
15. Maximum Mission radius	1100 n miles	750 n miles	2700 n miles	1200 n miles

(n miles = nautical miles)

Appendix 2.9 : Technique for studying the sea state and atmospheric disturbance by HF Doppler Radar and in the scatter mode monitoring of the ionosphere

2.339 HF Radar for Cyclone Monitoring[1]:

While CM wave radars are in general use for cyclone monitoring, a very new and powerful technique has recently been developed in the HF range which offers considerable promise. This is the HF Doppler radar. These operate at frequencees between 10-20 MHz, on peak pulse powers in the neighbourhood of a megawatt and use large antena arrays. These have been used for different purposes : as an Over-the-Horizon Radar, to study sea state from landlocked areas and for tracking and monitoring atmospheric disturbances. Since the radar signal can propagate via the ionospheric layers: the sky-mode operation can cover paths of few thousand kilometers. If groundmode is preferred, the distances are about 300-500 km

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* Note prepared by Dr. A.P. Mitra, Member of CRC.

2.340 Systems in operation:

Two major research systems for sea state or atmospheric disturbance studies are as follows:

University of Birmingham, U.K. : Professor Shearman

1) Skywave mode

Uses transmiteer at 100 kw, 3-20 MHz
Steerable antenna
Operates 1 or 2 hours every day
Operation area : North Atlantic (600 km)
(Propagation favourable when Sporadic E is present)

2) Ground mode

150 kw transmitter, 2 MHz, 50 μs, Omnidirectional surface wave - sea state upto 200 km.

Standford Research Institute, U.S.A. : Dr. J. Meresca

Both ground and skywave mode operations
Uses it for tracking and monitoring of hurricanes over the Gulf of Mexico.

Operates on 15 MHz, 49 vertical monopoles covering 300 m
Range 1000-3000 km
Range resolution ≃ 75 km.

2.341 Analysis of the technique :

Since the radars operate in a doppler-mode, velocities of the moving front in its different parts can be derived as a function of time. The system in New Mexico has been operated quite successfully for tracking gulf of Mexico storms. For surface mode operation the best location is on top of a cliff at and near the water line.

2.342 Assessment of the technique :

It is felt that there is both scientific and practical value an developing and installing at least one such system in the coast area of the Bay of Bengal, and to design the operation for both ground and skywave modes. Additionally the system should be used for seastate studies - these are expected to provide data of value as input for cyclone modelling. Technologically the development of an HF doppler radar has additional benefits as an Over-the-Horizon radar system.

Appendix 2.10 : Flood Forecasting Offices (FFOs)[1]

2.343 The Flood Meteorological Offices (FMOs) of the IMD in the coastal States of India:

Table 2.48 shows the location of the FMOs of the IMD in the coastal States and the self recording RGs under their management.

Table 2.48

Number of self recording rain gauges under each FMO in the coastal States of India

State	FMO	Taken over from WRD & FFD	Installed by IMD	Total
1. Gujarat	Ahmedabad	10	21	31
2. Andhra Pradesh	Hyderabad	-	18	18
3. Orissa	Bhubaneswar	7	27	34
4. West Bengal	Asansol	11	-	11

2.344 TC channels available at the FMOs in the coastal States:

The TC channels available/proposed at the FMOs are given in table 2.49

Table 2.49

The TC channels available at the FMOs

		TC Channels						
State	FMO	LL	TF	TP	TLX	WT	RTT	FAX
1.Gujarat	Ahmedabad	X	X	X	X	-	-	-
2.Andhra Pradesh	Hyderabad	X	X	X	X	-	X	-
3.Orissa	Bhubaneswar	X	-	X	X	At CWC & Public	X	X
4.West Bengal	Asansol	X	-	X	-	-	P	P

P = Proposed, X = exist

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* CMAS Meetings : Notes on Agenda.

Appendix 2.11 : Tide Gauge[2] stations used for storm surge monitoring[2]

2.345 Tide Gauge Stations (TGSs) on coastal India:

It has been mentioned in paragraph 2.78 that the Survey of India maintains 18 Tide Gauge Stations on coastal India. IMD proposed 15 more (IMDCP/4). But there is ground for serious doubt whether the existing Tide Gauge Stations function at all during cyclone regimes or whether the assessment of the maximum storm surge has to be made from level of the debris and artifacts dumped after the surge has passed. It is evident that considerable R&D work has to be done to find a proper design for instruments to measure simultaneously the storm surge levels and velocities and pressures exerted by the rushing water. Table 2.50 shows the locations of the existing and proposed Tide Gauge Stations set up by the Survey of India. Table 2.51 gives other Tide Gauge stations in coastal India set by other agencies/departments.

Table 2.50

Tide Gauge Stations on Coastal India

State	Location	Abbreviation	Existing	Proposed
1.Andhra Pradesh	1.Kakinada	KND	-	1
	2.Kalingapatnam	KLN	-	1
	3.Krishnapatnam	KPT	-	1
	4.Masulipatnam	MPT	-	-
	5.Visakhapatnam	VSK	1	1
	Total : 5		1	4
2.Goa	1.Marmagon	MMG	1	-
	Total : 1		1	0
3.Gujarat	1.Bhavnagar	BHV	1	-
	2.Broach	BRH	-	1
	3.Diu	DIU	1	-
	4.Kundla	KDA	1	-
	5.Okha	OKH	-	1
	6.Surat	SRT	-	1
	7.Veraval	VVL	1	-
	Total : 7		4	3

** IMD Cyclone Project.

State	Location	Abbreviation	Existing	Proposed
4.Karnataka	1.Karwar	KWR	1	-
	2.Mangalore	MNG	1	-
	Total : 2		2	0
5.Kerala	1.Cochin	CHN	1	-
	2.Kozhikode(Calicut)	CLT	-	1
	3.Trivandrum	TRV	-	1
	Total . 3		1	2
6.Lakshadwip Group	1.Minicoy	MNC	1	-
	Total : 1		1	0
7.Maharashtra	1.Bombay	BMB	1	-
	2.Ratnagiri	RTN	-	1
	Total : 2		1	1
8.Orissa	1.Balasore		-	1
	2.Gopalpur	GPL	--	1
	3.Paradeep	PRD	1	-
	Total : 3		1	2
9.Tamil Nadu	1.Cuddalore	CDL	-	1
	2.Nagapattinam	NPT	1	-
	3.Pamban	PBN	1	-
	4.Tondi	TND	-	1
	5.Tutticorin	TTC	1	-
	6.Vedaranniyan	VRN	-	1
	Total : 6		3	3
10.West Bengal	1.Calcutta		1	-
	2.Diamond Harbour		1	-
	3.Sagar Islands		1	-
	Total : 3		3	0

Table 2.51

Tide Gauge Stations set up by Organisations other than the Survey of India

State	Location	River	Management
West Bengal	1. Akra	Hooghly	Port Commissioners Calcutta (PCC)
	2. Bakshi	Roopnarayan	State Government (SG)
	3. Balari	Hooghly	PCC
	4. Bandar (Ghatal)	Roopnarayan	SG
	5. Diamond Harbour	Hooghly	PCC
	6. Dainan	Roopnarayan	SG
	7. Dhanipur	Roopnarayan	PCC
	8. Ganga	Hooghly	PCC
	9. Gopiganj	Roopnarayan	PCC
	10. Gopinathpure	Roopnarayan	PCC
	11. Haldia	Hooghly	PCC
	12. Hooghly Point	Hooghly	PCC
	13. Jhumjhumi	Roopnarayan	PCC
	14. Kalna	Hooghly	PCC
	15. K.G. Dock (Garden Reach)	Hooghly	PCC
	16. Konnagar	Hooghly	PCC
	17. Moyapur	Hooghly	PCC
	18. Mulajore	Hooghly	PCC
	19. Pavia Tungi	Roopnarayan	SG
	20. Soadihi	Roopnarayan	SG
	21. Tribeni	Hooghly	PCC
Proposed	1. Janera	Matla	
	2. Rasulpur	Matla	
	3. Saptamukhi	Matla	
	4. Takum	Matla	

Band	Frequency	Wavelength	Sub band	Frequency	Wavelength
	3 kHz	100 km			
VLF					
	30 kHz	10 km			
LF					
	300 kHz	1 km			
MF					
	3 MHz	100 m			
HF				(MHz)	(m)
				3.3	90
				5	60
				6.1	49
				7.3	41
				9.7	31
				12	25
				15.8	19
				18.8	16
				23.1	13
				27.3	11
	30 MHz	10 m			
VHF					
	300 MHz	1 m		230	1.3
			P	(GHz)	(cm)
UHF				1000=1GHz	30
			L		
	3GHz	10 cm		2	15
			S	4	7.5
			C		
				8	3.7
SHF (Micro-wave)			X		
				12.5	2.4
			K_u		
				18	1.7
			K		
				26	1.16
			K_a		
	30GHz	1 cm		40	0.75
MM waves					
	300GHz	1 mm			
	3THz	0.1mm = 100μm			
Infra red window					
	30THz	0.01mm = 10μm			
	3000 THz	1μm			
Optical Window					
	3000THz	0.1μm = 100nm			

Equation connecting wavelength with frequency :

λ(meter) x ν(MHz) = 300 meter sec^{-1}

Fig.2.47 : Electromagnetic frequencies used for telecommunication

Appendix 2.12 : Telecommunication Systems used for cyclone monitoring

2.346 Telecommunication channels (TCCs) in general use:

The usual channels of telecommunication (TC) may be quickly reviewed bringing out the special features which make them convenient for particular uses.

1. The land based wireborne TC systems:

These are essentially DC systems for transporting speeches or messages at audio frequency rate

a) Telephone (TLF): this is used for two way voice transmission to any address possessing the same facility. The linking of the sender to the address is through the telephone exchange. In India telephones are responsibilities of the P&T department.

b) Teleprinter (TP) : this is used between one fixed point address to another fixed point address for two way message transmission and printing. In large organisations whose various departments are spread all over the country and for which interdepartmental communications must be exchanged round the clock, such system are vital. Indeed the entire data collection system of the IMD is mainly based on the TP links established between the various centres. The teleprinter channels in India are controlled and managed by the Indian P&T department.

c) Telex (TLX): this is used for two way message transmission and printing to any addressee possessing the same facility. This is often used in large organisations as a back up facility to telephones. This is also under P&T department.

d) Telegraph/Telegram (TGM) : this is used for printed message (Telegram (TGM) transmission to any addressee. The actual transmission is done in post offices by morse codes, Within the country, telegrams are generally wire borne. The whole system in India is under the control and management of the Indian P&T department.

All these traditional channels of communication, being wire borne, are very prone to snap under stresses of natural disasters. Unfortunately that is the time when they are needed most.

2. Radio of Wireless Broadcasts :

In this mode of TC the electromagnetic waves are omitted isotropically or directed in a beam from specially designed antennas for all who have suitable receivers to listen to the transmitted messages contained as modulations on the carrier waves. The mode of transmission can take place in a numeer of ways depending on the frequency : 1) by ground waves which follows the curvature of the earth, 2) by multiple reflection between the ionosphere or the troposphere and the ground resulting in duct like conduction which makes possible transmissions for beyond the line of sight, 3) by travelling through space along the line of sight (LOS) and 4) by reflection from ground or other scattering surfaces. The message conveyed may be audio - Radio broadcast and Radio Telephone (RT), or video - picture or facsimile or may be printed by a teleprinter at the receiving end (RTP), or by wireless broadcasts of messages in morse code Wireless Telegraphy (WT). Facsimile transmission consists in first coverting a picture into dots and blanks and sending the information in digital form in a sequential scan. Picture transmission techniques make it possible to send the video information in various shades of black and white or in colour. The main uses of the broadcasts are :

1) Safety for the public : marine and aviation communication, police and fire protection, forest protection and high road traffic control,

2) Industrial power utilities, pipeline and relay services, agro and petroleum industry,

3) Transportation on land : railways, automobile traffic,

4) Broadcasting for entertainment and education: television AM/FM broadcasting,

5) Military and space application : radar communication, navigation telemetry, missile tracking and guidance, earth survey by satellites,

6) Fixed address to fixed address transmission: long distance telephony, message transmission and printing by TP, and picture/facsimile transmission,

7) Relaying : TV, sound, picture and printed message over large distances,

8) Telemetering : remote sensing of earth resources, testing of performance of aircrafts, missiles and satellites,

9) Meteorological reporting: rādiosondes, radio theodolites for measurement of winds, cyclone sensing and warning, general weather warning for the public and the industries.

10) Broadcasts of standards : time and frequency.

There applications do not of course exhaust all the uses to which such broadcasts are put. The amount of information transmitted depends on the bandwidth and therefore increases with the frequency of the carrier wave. In some applications depending on the frequency the carrier waves can be transmitted through cables, coaxial cables and wave guides. These cables/wave guides can be land based or can also be transported through seas and oceans.

3. Electromagnetic bands used in TC:

For the purpose of telecommunication the electromagnetic spectrum is divided in different bands and the names that have been given to them in course of the historical evolution of the technology. The different bands are demarcated in figure 2.47. The boundaries between the different bands are somewhat arbitrary and not as precise as indicated in the table, for there is no general agreement on this question. Each frequency region has its own peculiar characteristics which make it more suitable for certain applications than other frequency regions. The International Telecommunication Union (ITU) assigns specified frequencies from time to time to different users for their different tasks. The various applications and special features of the different regions of the electromagnetic spectrum in telecommunication is outlined below briefly.

A. VLF (Very Low Frequency or Very Long Wave)

Frequency range : 3-30 kHz, Wave Length : 100-10 km

Application : Aeronautical communication, navigation broadcasts of standards, communication via submarine cables, transoceanic communication.

Features : Transmission along ground and sea surfaces following earth's curvature, transmission through cables also sometimes employed. Lower the frequency lower is the attenuation of the ground wave.

B. LF (Low Frequency or Long Wave) :

Frequency range : 30-300 kHz, Wave length : 10-1 km

Application : Same as VLF Broadcasts

Features : Transmission along ground and sea surfaces following curvature of the earth. Transmission cables also sometimes employed. Attenuation of ground waves reduces with frequency. Used for broadcasting only in Europe, North Africa and throughout the Soviet Union. Normally heard over short to moderate distances dppending on power. Transmission may improve during hours of darkness and range of audibility increased.

C. MF (Medium Frequency or Medium Wave)

Frequency range :300kH$_2$-3MH$_2$ wave length : 1 km-100 m.

Application : Amateur radio broadcast, intra and international radio broadcast, hurricane warning, navigation. In India shore to coastal P&T radio station communication is based on MF broadcasts.

Features: Above 1.2 MHz the ground wave transmission along earth's curvature is independent of time of the day or season. Normally audible over short and medium distances for power 500 Watt at 2 MHz. The range falls off for higher frequency. Towards the higher frequency end the transmission may improve during hours of darkness and the range may also improve. Coaxial cable transmission is some times employed also. Used for broadcasting throughout the world. In India this is the most popular frequency range because of development of transistor receivers.

D. HF (High Frequency or Short Wave) ::

Frequency range : 3-30 MHz, Wave length : 100-10 m

Application : Amateur radio, intra and international broadcast, international communication, police and international broadcast, international communication police wireless, hurricane warning. Upper end is used for radio-astronomy for study of solar atmosphere.

Features : Transmission through space is by reflection at the ionosphere making very long distance transmission possible. The broadcast is prone to ionospheric disturbances caused by the sun. Coaxial cable transmission is also employed The 60 m band is used for broadcasting in tropical countries only. 41 m band is not used for broadcast in the western hemisphere at all. Reception in the 75-25m,band is usually good in the hours of darkness and in the 19-11m band during night times.

E. VHF (Very High Frequency or Very Short Wave)

Frequency range : 30-300 MHz, Wave length : 10-1 m

Application : Aeronautical communication, mobile radio vans, navigation, telemetry, VHF television radars (poor resolution but good coverage)

Features : Transmission through space is along LOS (line of sight). Due to tropospheric reflection same times under favourable meteorological conditions comparatively long distance transmission is ducted. In India the TV channels use this band with frequency modulation, which results in the broadcasts to be interference free and of high fidelity but of limited range imposed by LOS. Coaxial cable transmission is also employed. 65-73 MHz band is used in the Soviet Union and Several east European countries and 100-105 MHz band in western hemisphere. In India this TC system has come only recently.

F. UHF (Ultra High Frequency of Ultra short wave):

Frequency range : 300 MHz - 3 GHz, Wave length : 1m-10cm

Application : All LOS communications, earth-satellite communications, microwave relay, navigation, radioastronomy, satellite-satellite communication, telemetry, troposcatter, radar, UHF TV.

Features : Transmission is along LOS. Transmission by wave guides is also employed. Narrow directed beams are easy to produce in this region making this band very suitable for radar application. Portions of the spectrum in this region are given different code means : The S-band straddless both the UHF and the SHF. The Cyclone Warning radars in India use the S band. Sometimes under appropriate weather conditions the S band waves can be refracted beyond the radar horizon which causes errors in range estimation of some target detected by reflection of the incident waves In India radioastronomy is done at 20 cm.

G. SHF (Super high frequency or microwaves)

Frequency : 3-30 GHz. Wavelength : 10-1 cm

Application . Earth-satellite communication. All LOS communications, microwave relay, navigation, satellite-satellite communication, telemetry, troposcatter

Features : Transmission along LOS. Transmission by wave guides also employed. The Indian Railways have a wide spread TC system based on microwave linkage. The TC system of the INSAT System have S Band and C Band capabilities.

Figure 2.23 gives the frequency plan of INSAT-1A.

H. MMW (milimeter waves)

Frequency: 30-300 GHz, Wavelength : 10-1 mm

Application : LOS communications, satellite-satellite communication (Space-space link)

Features : Transmission by LOS. Transmission by wave guides have also been used.

I. Infra red Window :

Frequency: 3-30 THz, Wave length : 100- 10 μm

Applications : VHRR sensing of the earth from a satellite, LOS communications.

Features : Air borne radars, infrared lasers are used for LOS communications in military applications. Remote sensing by VHRR, very high resolution infrared instrument for sensing of the earth features from a satellite.

J. Optical Window :

Frequency: 200-300 nm (Ultraviolet) to 647-700 nm (Red) lying within the region 1500-428 THz.

Application : VHRR sensing of the earth from a satellite LOS Communications, space-space link, telemetry, and video-telephone.

Features : Laser beams may be used moving in space or moving through optical fibres. The VHRR can also do optical sensing of the terrestrial features from a satellite. For purpose of cyclone warning coded modulations of beams from light houses, light ships or beacons may be used. Laser communication is an emerging TC technology with great promise for the future because of band widths.

4. Other TC Systems:

Systems such as Sonar are not relevant for cyclone warnings. However sirens, loudspeakers, flares, rockets, light signals or mechanical signals, etc. are widely used with advantage for this purpose.

2.347 RTH-BROADCASTS[1]

In paragraph 2.106 mention has been made of the broadcast from the RTH-New Delhi - the two RTT broadcasts and the Facsimile (FAX) broadcast of analysis and prognosis charts prepared by the NHAC-New Delhi. The broadcasts can be received over a range of 6000 km round Delhi. The areas covered are

Area A : 45^{o}N - 25^{o}S, 30^{o}E - 125^{o}E

Area B : 0^{o}N - 40^{o}N, 30^{o}E - 125^{o}E

The FAX broadcasts are of special value to many categories of warnees including merchant ships. Table 2.52 gives the particulars of the two FAX broadcasts.

Table 2,52

FAX broadcasts from RTH - New Delhi

Call sign	Transmission Time (IST)	Frequency (kH_z)/ Wavelength (m)	Class of Omission	Bandwidth	Power (kilowatt)
ATS 57	2000-0730	7405/40.5	F4	White + 400 H_z Black - 400 H_z	20
	0800-1930 2000-0730	14842/20.2		-do-	20
ATP	0730-1930	18227/16.4		-do-	20

Table 2.53 gives the types of weather analysis and prognosis charts broadcast by FAX from RTH-New Delhi. The drum speed is 120 RPM and the index of cooperation is 576.

Table 2.53

Types of meteorological data broadcast in FAX from RTH Delhi

Area	Time of observation (IST)	Information Type	Transmission Time (IST)
I A	0530	Sea level analysis	1150-1208
	0530	850 mb analysis	1240-1258
	0530	700 mb analysis	1258-1316
	0530	500 mb analysis	1316-1334
	0530	300 mb analysis	1334-1352
	0530	Sea Level prognosis	1352-1410
	0530	200 mb analysis	1430-1448
	0530	500 mb prognosis	1553-1611
	0530	300 mb prognosis	1611-1629
	0530	250 mb prognosis	1629-1647

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* Weather Services to Shipping, Fishing Vessels and Maritime Interests : IMD (1974) Correction Slip No.3.

Area	Time of Observation (IST)	Information Type	Transmission Time (IST)
	0530	200 mb analysis	1647-1705
	0530	Tropopause/maximum wind prognosis	1705-1723
	0530	100 mb analysis	1723-1741
	1130	Sea Level analysis	1741-1759
	1730	Sea Level analysis	2350-0008
	1730	850 mb analysis	0040-0058
	1730	700 mb analysis	0058-0116
	1730	500 mb analysis	0116-0134
	1730	300 mb analysis	0134-0152
	1730	Sea Level analysis	0152-0212
	1730	200 mb analysis	0230-0248
	1730	500 mb prognosis	0353-0411
	1730	300 mb prognosis	0411-0429
	1730	250 mb prognosis	0429-0447
	1730	200 mb prognosis	0447-0505
	1730	Tropopause/Maximum	0505-0523
	1730	100 mb analysis	0523-0511
	2330	Sea level analysis	0546-0559
II B	0530	Significant weather prognosis for the period 1430-0230	1410-1428
	1130	Significant weather prognosis for the period 2030-0830	1854-1912
	1730	Significant weather prognosis for the period 0230-1430 of next day	0210-0220

2.348 THE TELECOMMUNICATION CHANNELS AVAILABLE AT THE VARIOUS METOROLOGICAL CENTRES IN THE COASTAL STATES[1] :

The telecommunication system available at the surface observatories including the Cooperative Cyclone Reporting Network Stations has been indicated in Appendix 2.3 (paragraph 2.322 and 2.323) tables 2.35 and 2.36. The TC system available at the different ACWC/CWCs have been indicated in paragraph 2.126 table 2.20. The meteorological centres in the coastal states equipped with WT are listed in table 2.21 (paragraph 2.127). Table 2.54 gives a list of the TC systems available in some other meteorological centres in the coastal states.

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* Working papers in particular papers 21 and 22 put before the Committee.

Table 2.54

Telecommunication Facilities available at various Meteorological Centres in Coastal States of India

For ACWC/CWCs : vide table 2.20
For Surface Observatories and Cooperative Cyclone Reporting Network Stations : vide table 2.35 and 2.36
For some MCs equipped with WT : vide table 2.21

State	Station	Abbre-viation	TP	TLX	WT	RTT	FAX
1. Andhra Pradesh	1.Hyderabad	HYD	X	X	-	X	X
	2.Tadapatri	TDI	X	-	-	-	-
	3.Visakhapatnam	VSK	X	X	X	X	X
2. Goa	1.Goa CMO	GOA	X	-	-	-	-
3. Gujarat	1.Ahmedabad SCC	AHM	X	X	-	X	X
	2.Rajkot MO	RJK	-	X	-	-	-
4. Karnataka	1.Bangalore MO/SCC	BNG	X	X	-	X	X
	2.Chitradurga MO	CHT	X	-	-	-	-
	3.Gadag MO	GDG	X	-	-	-	-
	4.Halabet	HAL	X	-	-	-	-
5. Kerala	1.Trivandrum MO/SCC	TRV	X	X	X	X	X
6. Maharashtra	1.Aurangabad MO	AGD	X	-	-	-	-
	2.Bombay MO/RCC	BMB	X	X	X	X	X
	3.Donapole CMO		X	-	-	-	-
	4.Nasik	NSK	X	-	-	-	-
	5.Pune		X	X	-	X	X
7. Orissa	1.Bhubaneswar MO/SCC	BWN	X	X	X	X	-
8. Tamil Nadu	1.Coimbatore MO	CMB	-	X	-	-	-
	2.Madurai MO	MDR	-	X	-	-	-
	3.Madras MO/RCC	MDS	X	X	X	X	X
	4.Tirichiraopalli MO	TRP	-	X	-	-	-
9. West Bengal	1.Alipore MO		-	X	-	X	-
	2.Calcutta RCC	CAL	X	X	X	X	X
	3.Jalpaiguri MO	JPG	X	-	-	-	-

Legend : X ≡ Exists, - ≡ No facility

T. Working papers into particular papers 21 and 22 put before the committee.

2.349 P&T COAXIAL LINKS AS ON JUNE 1982 IN THE COASTAL STATES OF INDIA[1] :

Table 2.55 gives the P&T coaxial links in the coastal states of India as on June 1982.

Table 2.55

P&T Coaxial Links as on June 1982 in the coastal states of India

Legend : WB = Wide Band, NB = Narrow Band, A = Analogue, D = Digital
Categories : I = Commissioned, II = under execution/planned

Link	Status
A. Circuits near the coast	
1. Calcutta-Kharagpur-Balasore-Bhadrak-Cuttack-Bhubaneswar-Bhrampur/Ganjam-Srikakulam-Vijayanagram-Visakhapatnam-Tuni-Rajmundry	One A/WB/I One A/WB/II
2. Rajamundry-Elluru-Vijawada	One A/WB/I
3. Rajamundry-Ravalapalavem-Tadipalligudem	One A/NB/I One A/WB/II
4. Rajamundry-Smalkot-Kakinada	One A/NB/I
5. Ravalapalavem-Mardapeta	One A/NB/II
6. Ravalapalavem-Amalapuram	One A/NB/II
7. Vijawada-Guntur-Ongole-Nellore-Guddur-Madras	One A/WB/I One A/WB/II
8. Vijawada-Kodad-Suryapet-Secunderabad	One A/WB/I One A/WB/II
9. Kodad-Khammam	One A/NB/I
10. Madras-Pondicherry-Cuddalore-Mayuram-Khumbhakkonam-Tanjavur	One A/WB/I
11. Madras-Tiruchirapalli	One A/WB/I
12. Tirruchirapalli-Tanjavur-Thiruvarur-Managudi-Nagupattinam	One A/NB/I
13. Tiruchirappali-Coimbatore	One A/WB/I
14. Tiruchirapali-Dindigul-Madurai-Virudhunagar Tirunelvelli	One A/WB/I
15. Tirunelvelli-Tuticorin	One A/NB/I
16. Tirunelvelli-Ambasundaram	One A/NB/I

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* Informations provided by Shri P. Lalwani Director (MR) P&T Department.

Link	Status
17. Tirunelvelli-Tenkasi-Sankaracoil	One A/NB/II
18. Tirunelvelli-Nagarcoil-Trivandrum-Quilon-Kottyam-Ernakulam-Alwaye	One A/WB/I
19. Alwaye-Perumbavoor-Kothamangalam-Muratnupuzna-The dupuzha	One A/NB/II
20. Alwaye-Kunankulad-Ponani-Tirur-Kozhikode	One A/NB/I
21. Alwaye-Palghat	One A/WB/I
22. Palghat-Coimbatore	One A/WB/I
23. Coimbatore-Tirupar-Erode	One A/WB/II
24. Erode-Bhavani	One A/NB/II
25. Erode-Trichnagode-Namkhal	One A/WB/I
26. Erode-Salem	One A/NB/I
27. Palaghat-Ottapalam-Perintalman	One A/WB/I
28. Perintalman-Mannarghat	One A/NB/I
29. Perintalman-Malapuram-Maryeri	One A/WB/I
30. Maryeri-Kozhikode	One A/WB/I
31. Manjeri-Nilambur	One A/NB/II
32. Cannanore-Poyganur-Mankangode-Kasargode-Mangalore	One A/NB/II
33. Madras-Vellore	One A/WB/I
34. Vellore-Chittoor	One A/NB/II
35. Vellore-Arni-Tirunelmallai	One A/NB/I
36. Vellore-Bangalore	One A/WB/I
37. Vellore-Krishnagiri	One A/WB/II
38. Krishnagiri-Bangalore	One A/WB/I
39. Bangalore-Davangire-Hubli-Belgaum-Kolhapur	Two A/WB/I
40. Kolhapur-Sangli	One A/NB/I
41. Kolhapur-Ichalkranji	One A/NB/II
42. Kolhapur-Pune	One A/WB/I

	Link	Status
43.	Kolhapur-Korad-Satara-Pune	One A/WB/I
44.	Pune-Cinch-Thana	One A/WB/I
45.	Pune-Cinch-Kalyan-Thana	One A/WB/II
46.	Thana-Bombay	One A/WB/I
47.	Thana-Panvel	One A/NB/II
48.	Thana-Nasik-Manmad-Dhulia	One A/WB/I
49.	Thana-Bulsar-Surat	One A/WB/I
50.	Surat-Bardoli-Vyara-Naupur-Nandurbar-Dondiacha-Dhulia	One A/NB/II
51.	Surat-Baroda	One A/WB/I
52.	Baroda-Anand	One A/NB/II
53.	Baroda-Ahmedabad	One A/WB/I
54.	Ahmedabad-Surendranagar-Rajkot	One A/WB/I One D/WB/II
55.	Rajkot-Gondal-Jaitapur-Dhoraji	One A/NB/I
56.	Dhoraji-Upleta-Porbandar	One A/NB/I
57.	Dhoraji-Junagarh-Kishod-Veraval	One A/NB/I
B.	Circuits to Delni	
1.	Delhi-Mathura-Agra-Kanpur-Varanasi-Sasaram-Asansol-Ranigunge-Burdhwan-Calcutta	One A/WB/I
	Mathura-Agra	One A/NB/II
	Allahabad-Varanasi	One A/WB/II
	Burdhwan-Calcutta	One A/WB/II
2.	Delhi-Meerut-Hapur	One A/WB/I
	Delhi-Hapur	One A/WB/I
	Hapur-Bareilly-Shahjahanpur-Sitapur-Lucknow-Raibareilly-Mirzapur-Allahabad	One A/WB/I One A/WB/II
	Kanpur-Lucknow	One A/WB/I One A/NB/I

	Link	State
	Varanasi-Buxur-Patna	One A/WB/II
	Sasaram-Patna	One A/WB/I
	Patna-Calcutta	One A/WB/II
3.	Agra-Jaipur-Beawar-Udaipur-Himmatnagar-Ahmedabad-Baroda-Surat-Thana-Bombay	One A/WB/I
	Jaipur-Beawar-Udaipur-Himmatnagar-Ahmedabad	One A/WB/I
4.	Bangalore-Hindupur-Anantapur-Gunlakal-Kurnool-Mahaboobnagar-Secunderabad-Karnareddy-Nizamabad-Nirmal-Adilabad-Pandarakwada-Yeothmal-Wardha-Nagpur-Amraoli-Akola-Bhusral-Jalgaon-Dhulia-Manmad-Nasik-Thana-Bombay.	One A/WB/I
5.	Nagpur-Seoni-Jabalpur-Damon-Sagar-Lalitpur-Jhansi-Gwalior-Agra	One A/WB/II

2.350 P&T UHF NETWORK IN COASTAL STATES OF INDIA UPTO 31.10.1982[1]:

Table 2.56 gives the UHF network in the coastal states commissioned upto December 1982 as also those under execution or being planned

Table 2.56
UHF network in coastal states of India upto 31.10.1982

Legend : Category : I = Commissioned, II = under Execution, III = Planned

	Link	Status
1.	Calcutta-Haldia	I
2.	Diamond Harbour-Kulpi	III
3.	Mdinapore-Kharagpur	II
4.	Baripada-Balasore	II
5.	Keonjhar-Jajepore	III
6.	Cuttack-Paradeep	I
7.	Phulbani-Berhampur (Ganjam)	III
8.	Kakinada-Yanam	III
9.	Tenali-Bapalta	II

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* Information provided by Shri R. Lalwani Director (MR) P&T Department.

Link	Status
9. Tenali-Bapalta	II
10. Sattanpalle-Guntur	III
11. Guntur-Narasaropet	II
12. Shriharikota-Madras	I
13. Madras-Kanchipuram	II
14. Cuddalore-Neyocli	II
15. Jhanjavur-Puttukottai	II
16. Tirichirapalli-Pudukotai	I
17. Madurai-Permakudi-Ramanathpuram	II
18. Mandapam-Rameshwaram-Manar (Shrilanka)	I
19. Rajapalayam-Virudhanagar-Sivkashi	I
20. Quillon-Punnalur	II
21. Palai-Kottayam	I
22. Kottayam Nanjirapalli	III
23. Kottayam-Peermedi	III
24. Shertalai-Allepy	II
25 Ernakulam-Idukiki-Munnar	II
26. Trichur-Kanamkulam	I
27. Kozhikode-Badagra	I
28. Kozhikode-Kalapata	I
29. Kozhikode-Manjiri	I
30. Mangalore-Udipi	I
31. Mangalore-Maleswara	I
32. Mangalore-Bantwal	II
33. Mangalore-Puttur	I
34. Targod-Sirsi	II
35. Panjim-Mapuga	II

Link	Status
36. Panjim-Ponda	II
37. Panjim-Vasco	I
38. Panjim-Karwar	I
39. Hathikhambha-Ratnagiri	II
40. Bombay-Butcher Island	III
41. Bombay-Alibagh	II
42. Bombay-New Bombay	I
43. Bombay-Pan	II
44. Bulsar-Silwasa	III
45. Bulsar-Ahwa	III
46. Ahmedabad-Talod	II
47. Ahmedabad-Nadiad	I
48. Nadiad-Kapadwand	II
49. Ahmedabad-Bhavnagar-Savarykundla	I
50. Bhavnagar-Botad	III
51. Bhavnagar-Mahuva	II
52. Savarykundla-Amerli	III
53. Okha-Dwarka-Khambaliva	II
54. Morvi-Rajkot-Wankaner	II
55. Surendranagar-Dhargandhra	II

2.351 P&T MICROWAVE NETWORK IN THE COASTAL STATES OF INDIA[1] :

Table 2.57 gives the Microwave network in the coastal states (wide and narrow bands in analogue/digital modes) completed, under execution and being planned.

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* Informations provided by Shri R.Lalwani Director(MR) P&T Deptt.

TABLE 2.57

P&T MICROWAVE NETWORK IN THE COASTAL STATES OF INDIA

Legend : WB = Wide Band, NB = Narrow Band, A = Analogue, D = Digital
Categories: I = Completed, II - under Execution, III = Planned

	Link	Status
1.	Circuits near the coast	
1.	Calcutta-Uluberia-Haldia	One A/NB/III
2.	Calcutta-Kharagpur	Two A/WB/I
3.	Kharagpur-Cuttack	One A/WB/II
4.	Cuttack-Dhenkanal	One A/NB/II
5.	Cuttack-Bhubaneswar	One A/WB/III One D/NB/II
6,	Cuttack-Berhampur/Ganjam-Srikakulam-Visakhapatnam-Rajmundry(Kotabommuri) Vijawada	One A/WB/II
7.	Vijayawada-Secunderabad	One D/WB/III
8.	Vijayawada-Teunali-Guntur	One A/NB/I
9.	Guntur-Ponnura-Bapatpa	One A/NB/II
10.	Bapatpa-Chirala	One A/WB/III
11.	Guntur-Chilakularipeta-Sattenapalli	One A/NB/III
12.	Vijawada-Nellore-Madras	One A/WB/III
13.	Madras-Bangalore	One A/WB/I
14,	Madras-Tirupati	One A/NB/I
15.	Madras-Kanchipuram	One A/NB/III
16.	Madras-Salem-Tiruchirapalli-Madurai-Rameswaram-Jaffna (Shrilanka) Colombo(Shrilanka)	One A/WB/I
17.	Coimbatore-Pallachi-Ernekulam	One A/WB/II
18.	Trivandrum-Alleppy-Ernekulam-Kozhikode-Mercara-Mangalore	One A/WB/I

	Link	Status
19.	Tiruchirapalli-Pudukottai	One A/NB/III
20.	Madurai/Daraikodi	One A/NB/III
21.	Madurai/Virudhunagar	One A/WB/III
22.	Virudhunagar-Sivakashi	One A/NB/I One A/WB/III
23.	Sivakashi-Tiruruvengaville-Trivandrum	One A/WB/III
24.	Alleppy-Kottijam	One A/NB/II One A/WB/III
25.	Ernekulam-Irinjalakuda	One A/NB/III
26.	Ernekulam-Alwaye	One A/NB/II
27.	Trichur-Konnambumbal	One A/NB/II
28.	Kozhikode-Tirur-Ponnani	One A/NB/II
29.	Kozhikode-Tellicherry-Cannanore	One A/NB/I
30.	Coimbatore-Kodaikanal-Madurai	One A/WB/III
31.	Ooty-Coonoor	One A/NB/I
32.	Coimbatore-Coonoor	One A/NB/I
33.	Coonoor-Kozhikode	One A/NB/I
34.	Coimbatore-Ooty-Mysore	One A/WB/III
35.	Mysore-Mercara	One A/WB/I One A/NB/II
36.	Kozhikode-Mangalore-Panjim	One A/WB/I
37.	Mysore-Bangalore	One A/WB/I
38.	Bangalore-Hassan	One A/WB/III
39.	Guntukal-Belgaum	One A/WB/III
40.	Mangalore-Uddipi-Coondapur	One A/NB/II
41.	Panjim-Vasco-Murmagaon-Karwar	One A/WB/III
42.	Panjim-Belgaon	One A/NB/I One A/WB/III

	Link	Status
43.	Panjim-Bombay	One A/WB/I
44.	Secunderabad-Sholapur-Pune-Bombay	One A/WB/I
45.	Panjim-Pune	One A/WB/I
46.	Pune-Ratnagiri	One D/NB/I
47.	Bombay-New Bombay	One A/NB/I
48.	Bombay-Surat-Baroda-Ahmedabad	One A/WB/III
49.	Surat-Broach-Bhavnagar-Amreli-Rajkot-Jamnagar	One A/WB/II
50.	Jamnagar-Khambala	One A/NB/II
51.	Ahmedabad-Nadiad	One A/WB/II
52.	Nadiad-Codhra	One A/NB/III
53.	Ahmedabad-Kaira-Cambay	One A/NB/II
54.	Ahmedabad-Bhavnagar	One A/WB/II
55.	Bhavnagar-Mahuva	One A/NB/III
56.	Junagarh-Manvadar	One A/NB/II
57.	Jamnagar-Kandla (Gandhigram)-Bhuj	One A/NB/I
58.	Rajkot-Morvi	One A/NB/III
59.	Dhargandhra-Surendranagar	One A/NB/II
B.	Circuits to Delhi	
60.	Delhi-Agra-Kanpur-Lucknow-Gorakhpur-Patna-Asansol-Calcutta	One A/WB/I
61.	Cuttack-Sambalpur	One A/WB/II
62.	Sambalpur-Raipur-Nagpur	One A/WB/I
63.	Secunderabad-Nizamabad-Chandrapur (Chanda)-Nagpur	One A/WB/II
64.	Bangalore-Guntakal-Raichur-Secunderabad	One A/WB/II
65.	Nagpur-Jabalpur-Sagar-Agra-Delhi	One A/WB/I

	Link	Status
66	Bombay-Thana-Dhulia-Nagpur	One A/WB/I
67.	Bombay-Dhulia-Indore-Kotah-Jaipur Alwar-Delhi	One A/WB/I
68.	Ahmedabad-Ratlam-Indore	One A/WB/I

2.352 POLICE COMMUNICATION NETWORK IN THE COASTAL STATES OF INDIA :

In each state the Police Department has a very elaborate communication network connecting all the police stations in the State. Generally this communication network is based on WT/RT systems. But recently in many states the communication system is being modernised by addition of VHF/UHF/Microwave system. So far the coastal states on the east coast are concerned, in Orissa there are WT units at Balasore, Chandbali, Gopalpur, Paradeep in the coastal districts. In the CDMC-Orissa report it was recommended that Police WT stations be restarted at Basta, Ersama, Mahakalpara and Noapara. It was also recommended that Police WT facilities be provided at Bramhagiri. In Tamilnadu the Police WT system has often been used for Cyclone Warning dissemination. Table 2.58 gives the location of some of the WT stations in the coastal districts. In West Bengal the RT system is extensively used. Table 2.59 gives some of the locations of the WT/RT stations in the coastal regions of West Bengal which were listed by the CDMC-West Bengal when considering a number of locations for a CCRN for the state.

TABLE 2.58

POLICE WT STATIONS IN THE COASTAL DISTRICTS OF TAMILNADU[1]

	District	Station
1.	Chingelput	Mahabalipuram
2.	Karaikal	Karaikal
3.	Ramnathpuram	1. Devipatnam 2. Killakarai 3. Rameshwaram
4.	Thanjavur	1. Manamelleudi 2. Tranquibar
5.	Tirunelvelli	Trichendur
6.	South Arcot	Marakkanam

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* [1] IMD Cyclone Manual Part 2

TABLE 2.59

POLICE WT/RT STATIONS IN THE COASTAL DISTRICTS OF WEST BENGAL [2]

District	Station	Facility	Status	Availability of P&T facilities	Distance from coast
I Midnapore	1. Contai	WT/RT		Yes	10 km on the coast
	2. Digha	RT		Yes	
	3. Geonkhali	WT	Temporary		On R.Roopnarayan about 60 km from coast line
	4. Haldia	RT		Yes	On the coast of R.Haldi. 30 km from coast line
	5. Khajuri	RT		No	3 km
	6. Kolaghat	WT	Temporary	Yes	On R.Roopnarayan 60 km from coast
	7. Mahisadal	RT		Yes	About 40 km
	8. Mayna	RT		Yes	On coast of R. Haldi about 57km from coast line
	9. Nandigram	RT		[illegible]	17 km
	10. Ramnagar	RT		Yes	5 km
	11. Suthata	RT		Yes	About 57 km
II 24 Parganas	1. Basanti	RT		No	About 72 km
	2. Budge	RT		Yes	On R.Hooghly 93km from coast
	3. Canning	RT		Yes	On R.Vidyadhari 56 km from coast
	4. Diamond Harbour	WT/RT		Yes	On R.Hooghly 63km from coast
	5. Falta	RT		Yes	On R.Hooghly 72km from coast
	6. Gosaba	WT/RT		No	On R.Bidya 72 km from coast
	7, Haroa	RT		Yes	105 km

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* [2] Report of the CDMC - West Bengal (1974)

Table 2.59 (Contd.)

District	Station	Facility	Status	Avaiability of P&T facilities	Distance from coast
	8.Hasnabad	RT		Yes	On R/Haribhanga 100 km from coast.
	9.Hingalganj	RT		No	On R.Haribhanga 95 km from coast
	10.Joynagar (Joynagar/ Mazilpur)	RT		Yes	66 km
	11.Kakdwip	WT/RT		Yes	On R.Hooghly 33 km from coast
	12.Kulpi	RT		Yes	58 km
	13.Magrahat	RT		Yes	74 km
	14.Mathurapur	RT		Yes	60 km
	15.Namkhana	WT/RT		Yes	22 km
	16.Patharpratima	RT		Yes	10 km
	17.Sandeshkhali	RT		No	On R.Rathangal 83 km from coast

Appendix 2.13 : Cyclone Service at sea ports[1] :

2.353 INDIAN SEAPORTS RECEIVING WEATHER INFORMATIONS:

Table 2.60 gives the names of the ports on the Indian coast that receive cyclone warnings/informations. The ports under the groups EXTN, GENL and BRIF hoist visual storm signals describing in this appendix paragraph.

2.354 ACWC-Calcutta warns the ports on the West Bengal coast. CWC-Bhubaneswar and Visakhapatnam warns the ports on the Orissa and Andhra Pradesh respectively. ACWC-Madras warns all the ports on the Arabian Sea south of and including Karwar. ACWC-Bombay warns all the ports on the Arabian Sea north of Karwar.

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* Code of Storm Warning Signals for use at Indian Maritime Ports : IMD (1956) corrected till 1979. Cyclone Manual : Chapter 9 IMD (1979)

Table 2.60

Indian ports under the Cyclone Warning System

	Under ACWC/CWC	State	Type	Ports	Total Number
A.East Coast	I Bhubaneswar	1.Orissa	GENL	1.Gopalpur 2.Paradeep	2
			BRIF	1.Chandbali 2.Puri	2
	II Calcutta	1.Andaman Group	GENL	Port Blair	1
		2.West Bengal	EXTN	1.Sagar Island	1
			GENL	1.Calcutta 2.Budge Budgel 3.Diamond Harbour	3
	III Madras	1.Pondicherry	BRIF	1.Pondicherry	1
		2.Tamil Nadu	EXTN	1.Calcutta 2.Madras 3.Nagapattinam	3
			GENL	1.Pamban 2.Tutticorin 3.New Tutticorin	3
			BRIF	1.Killakarai 2.Kolachel	2
			SMAL	1.Ramaswaran	1
	IV Visakhapatban	1.Andhra Pradesh	EXTN	1.Kakinada	1
			GENL	1.Musalipatnam 2.Visakhapatnam	2
			BRIF	1.Bhimunipatnam 2.Kalingapatnam 3.Krishnapatnam 4.Vederevu	4
B.West Coast	I Bombay	1.Goa	GENL	1.Marmagon	1
			BRIF	1.Daman,Diu	2
			GENL	1.Bhavnagar 2.Jamnagar (Bedi) 3.Mandavi 4.Navalakhi 5.New Kandla 6.Okha 7.Porbandar 8.Veraval	8
			BRIF	1.Billimora 2.Bharach 3.Dehej 4.Delvada (Nayabandar) 5.Dwarka (Rupen) 6.Gogha 7.Jafarbad 8.Jakau 9.Madhwad	20

Under ACWC/CWC	State	Type	Ports	Total Number
			10.Mahuva	
			11.Mangrol	
			12.Maroli	
			13.Mudra	
			14.Rajula (Pipavan)	
			15.Salya	
			16.Sikka	
			17.Surat(Magdalla)	
			18.Teleja	
			19.Umbergaon	
			20.Vatsad	
		SMAL	1.Bhagwa	6
			2.Kolak (Udvada)	
			3.Manori	
			4.Onjal	
			5.Umersodi	
			6.Vansi-Bored	
	3.Maharqshtra	GENL	1.Bombay	1
		BRIF	1.Agashi(Arnalla)	22
			2.Alibagh	
			3.Andheri(Versova)	
			4.Dabhol	
			5.Dahanu	
			6.Dantiwara	
			7.Devgarh	
			8.Harnai	
			9.Jaitapur	
			10.Janjira (Murud)	
			11.Jaygarh	
			12.Kalyan	
			13.Kelve Mahim	
			14.Malvan	
			15.Nawapur (Balsar)	
			16.Ratnagiri	
			17.Redi Shiroda	
			18.Tarapur	
			19.Thana	
			20.Uttan(Bhayandar)	
			21.Vengurla	
			22.Vijaydurg	
		SMAL	1.Bandra	5
			2.Mora (Uran)	
			3.Revdandanda	
			4.Ulwa	
			5.Varoda Malgund	

Under ACWC/CWC	State	Type	Ports	Total Number
	2.Kerala	GENL	1.Alleppey 2.Baypur 3.Calcut 4.Cochin	4
		BRIF	1.Azhikkal(Beliapatnam) 2.Badagara 3.Cannanore 4.Kolachel 5.Neendakara 6.Ponnani 7.Tellecherry 8.Trivandrum	8
	3.Lakshadwip	BRIF	1.Minicoy	1

2.354 VISUAL STORM SIGNALS HOISTED AT SEA PORTS ON INDIAN COAST[1] :

In paragraph 2.151 it has been stated that there are three systems of storm warnings for Indian ports : 1) The General system (GENL) consisting of 11 signals of which two indicate distant disturbed weather, eight indicate local bad weather threating port and one indicates failure of communication, 2) The Brief System (BRIF) which uses 5 of these 11 signals of the GENL system for ports visited by small vessels, 3) The extended system (EXTN) used for some ports on the Bay of Bengal which gives the location of the storm also. In the last system all the local signals of the GENL system are used as usual if the port is threatened. But if the storm for away, the distant signals : Distant Cautionary and Distant Warnings of the GENL system are hoisted with the area. Signal positioned under the other signals gives the location in one of the five zones in which the Bay is divided, 4) The SMAL system covers those smaller ports which receive the warnings but do not hoist signals. The port storm signals are hoisted during both day and night. The way in which the signals are made up are explained in Table 2.61. The actual visual signals hoisted and their significance is explained in Table 2.62.

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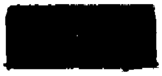
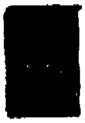
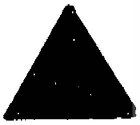
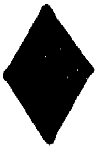
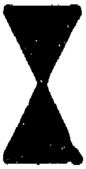
* Code of storm warning signals for use at Indian ports: IMD (5th Edition corrected upto 1979)

Table 2.61

Component part of visual storm signals hoisted at the Indian ports

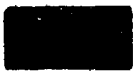
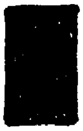
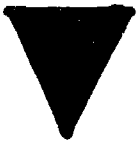
Item	Visual	Material	Dimension	Composition
A. Day signals				
1. Horizontal Bar		Drum	Diameter = 4 ft. Axis = 2 ft.	
2. Vertical		Drum	Diameter = 2 ft. Axis = 4 ft.	
3. Triangle		Cone	Base diameter = 4 ft. Axis = 4 ft.	
4. Diamond		Two cones attached base to base.	Each cone : Base diameter	
5. Hour Glass		Two cones of Diamond(4) above attached vertex to vertex	Same as (4)	

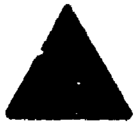
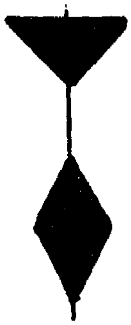
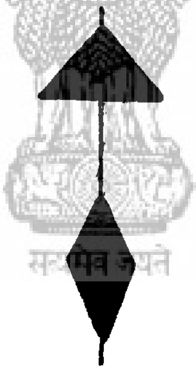
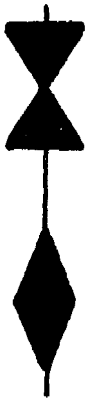
Item	Visual	Material	Dimension	Composition
6. All Distant signals and only these				Horizontal or Vertical Bar as their upper member
7. All local signals and only these				A triangle or an Hour glass as upper member
8. Cautionary and Warning signals, Distant and Local				Only one member
9. EXTN system				In addition to signal 7 additional members hung below to indicate storm position
10. Both Danger and Great Danger signals				Contains two members. For Danger lower member is always a diamond and for great Danger it is a vertical bar. Upper member is always a triangle (pointing up: North, pointing down: South) showing the storm position with respect to pot, or an hourglass indicating proximity to port
11. Failure of communication signals				Only hourglass
12. Distance between components				3 ft
B. Night Signals				
1. Lamps		Electric Lamps O Red O White		
2. Cautionary and Warning signal				Two Lamps each

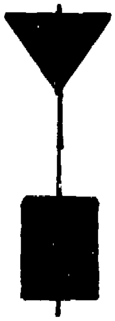
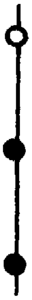
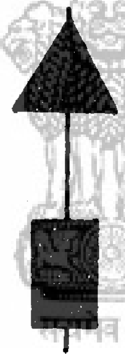
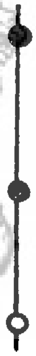
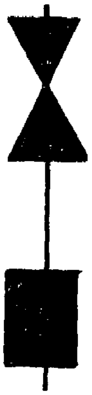
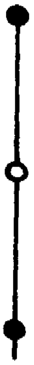
Item	Visual	Material	Dimension	Composition
3. Danger and Great Danger signals				Three lamps each. Intensity of Danger indicated by number of Red Lamps. Danger : One Red Lamp Great Danger:Two Red Lamp Position of red lamps indicates where with respect to port the storm would pass. Red Lamp/lamps in upper part indicates passage to north. Red lamp in the middle or two Red lamps Symmetrical about centre mean storm would pass over port. Red lamps/ lamp in lower part mean storm would pass south of port.
4. Failure of communication signals				One lamp
5. Distance between lamps				6 ft.

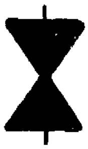
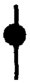
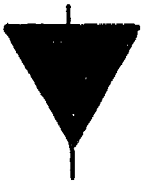
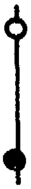
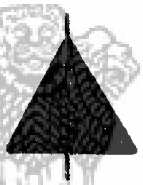
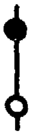
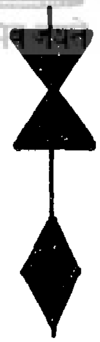
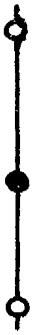
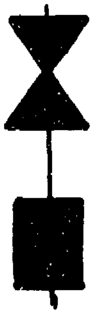
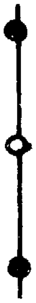
Table 2.62

Visual warn signals histed at Indian of ports

Type of Warning	Signal Number	Visual Signal Day	Vishal Signal Night	Significance
The General System				
1. Distant signal: Cautionary	I			There is a region of squally weather in which a storm may be forming.
2. Distant signal: Warning	II			A storm has been formed
3. Local signal: Cautionary	III			The port itself and the ships are threatened

Type of Warning	Signal Number	Visual Signal Day	Visual Signal Night	Significance
4. Local signal: Warning	IV			The port and the ships are threatened by a storm, but it does not imply that the danger is sufficiently, great to justify extreme measures of precautions
5. Local signal: Danger	V			The port will experience weather from a storm of slight or moderate intensity that is expected to cross the coast to the south of the port, or to the east in the case of Veraval, the Hooghly ports and Port Blair.
6. Local signal : Danger	VI			The port will experience weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port, or to the West in the case of the Hooghly ports and port Blair.
7. Local signal : Danger	VII			The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross over or near to the port

Type of Warning	Signal Number	Visual Signal Day	Visual Signal Night	Significance
8. Local Signal : Great Danger	VIII			The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port or to the east in the case of Veraval, Hooghly ports and Port Blair.
9. Local Signal : Great Danger	IX			The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port or to the west in the case of Hooghly ports and Port Blair
10. Local Signal : Great Danger	X			The port will experience severe weather from a storm of great intensity that is expected to cross over or near to the ports. The signal is also hoisted when a severe storm is expected to skirt the coast without actually crossing it.

Type of Warning	Signal Number	Visual Signal Day	Visual Signal Night	Significance
11. Local Signal: Failure of Communications	XI			Communications with the meteorological warning centre have broken down and the local officer considers there is danger of bad weather
II. Brief System				
1. Cautionary	III			Used in more ports, Employs only 5 of the signals of the general system
2. Warning	IV			
3. Danger	VII			
4. Great Danger	X			

Type of Warning	Signal Number	Visual Signal Day	Visual Signal Night	Significance
5. Failure of communication	XI			
III. Extended System : Area Signals				Used in certain Bay of Bengal Ports. If the port itself is threatened the appropriate local signal of the General System is used. But if the port is not threatened The Distance Signal: Cautionary or Warning of the General System is used with the area signals below it giving the location of the storm. The area Signals are 5 in number corresponding to 5 divisions of the Bay of Bengal.
1. Section I North Bay: North of 18.5°N		▼		
2. Section II West Central Bay : South of I to 13°N and to ast 88.5°		▮		
3. Section III East Central Bay : South of I upto 13°N and east of II upto 93°		◆		
4. Section IV South West Bay : South of II and west of 86°		▬		
5. Section V east of IV upto 93°		▲		
6. Section VI east of III and V		⧗		

Appendix 2.14: Meteorological with respect to cyclones rendered to sea/coastal traffic[1]

2.355 TIMINGS AND FREQUENCIES OF BROADCASTS OF WEATHER BULLETINS FROM VARIOUS P&T COASTAL RADIO STATIONS ADDRESSED TO SHIPS/COASTAL BOATS :

Table 2.63 gives the timings and frequencies of weather bulletins broadcast by the various coastal P&T stations.

Table 2.63

Timing and Frequency of broadcast of weather bulletins from various P&T coastal radio stations to ships

Sea Bulletin part	Bombay (VWB)		CALCUTTA (VWC)		MADRAS (VWM)	
	Timing (IST)	Frequency (KHz)/Wave length (m)	Timing (IST)	Frequency (KHz)/Wave length(m)	Timing (IST)	Frequency (KHz)/Wave length(m)
A. Daily						
1. Part I	1418	500/600 8630/36.4 12710/23.6	1448	500/600 12745.5/23.3	1500	500/600 8674.4/34.6
	2248	do	2348	do	2400	do
2. Part II, III, IV	1418	do	1448	470/638.3 12745.5/23.3	1500	515/582.5 8674.4/34.6
	2248	do	2348	470/638.3 4286/70	2400	do
3. Part V,VI	1148	do	1418	470/638.3 12745.5/23.3		
	2048	do	1948	470/638.3 8526/35.2		
Madras does not broadcast IV,V,VI						
B. Extra						
Part I	0518	do	0548	500/600 4286/70	0600	do
C. Storm						
Part I	0218	do	0248	do	0300	do
	1018	do	1048	500/600 8526/35.2	1000	do
	1818	do	1848	500/600 12745.5/23.3	1900	do

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* Weather Service to Shipping, Fishing Vessels and Maritime Interest:IMD(1974) Correction slip number 3

Sea Bulletin part	Bombay (VWB)		Calcutta (VWC)		Madras (VWM)	
	Timing (IST)	Frequency (KHz)/Wave length (m)	Timing (IST)	Frequency (KHz)/Wave length (m)	Timing (IST)	Frequency (KHz)/Wave length (m)
D. Special Part I	Any Time	500/600 8630/36.4 12710/23.6	Any time	500/600 8526/35.2	Any time	515/582.5 8674.4/34.6

The significance of terms - Daily, Extra, Storm, Special, Parts I, II, III, IV, V, VI has been explained in paragraph 2.152.

2.356 METEOROLOGICAL OBSERVATORIES LINKED TO P&T COASTAL P&T RADIO STATIONS :

Bombay and Calcutta P&T radio stations include reports of groups of observatories as shown in table 2.64

Table 2.64

	Radio Station	State	Observation Type	Coastal Observatories
I	Bombay	1. Gujarat	Synoptic	Bhavnagar, Bhuj, Dwarka, Surat, Veraval
			Upper Air Report (UAR)	Bhuj, Surat, Veraval
		2. Goa	Synoptic	Panjim
		3. Kerala	Synoptic	Alleppey, Calicut, Port Cochin, Trivandrum
			UAR	Cochin/Wellington, Trivandrum
		4. Lakshadwip	Synoptic	Amini, Minicoy
			UAR	Amini, Minicoy
		5. Maharashtra	Synoptic	Bombay/Colaba, Debgarh Harnai, Ratnagiri Sholapur,
			UAR	Bombay/Santa Cruz, Ratnagiri
		6. Tamil Nadu	Synoptic	Kanyakumari
II	Calcutta	1. Andaman Group	Synoptic	Port Blair
			UAR	Port Blair
		2. Andhra Pradesh	Synoptic	Begumput, Cuddappah, Kalingapatnam, Kakinada, Masulipatnam, Nellore, Ongole, Visakhapatnam,
			UAR	Vijayawada/Gannavaram Visakhapatnam

Radio Station	State	Observation Type		Coastal Observatories
	3.Karnataka	Synoptic	:	Bangalore
	4.Orissa	Synoptic		Balasore, Chandbali,Gopalpur, Paradip, Puri, Sambalpur
		UAR	:	Bhubaneswar, Gopalpur
	5.Tamil Nadu	Synoptic	:	Cuddalore, Kanyakumari, Madras/Minabakam, Nagapattinam, Pamban, Tiruchira-Palli.
	6.West Bengal	Synoptic	:	Berhampur, Calcutta/Alipore Daltongunje, Sandheads, Sagar Island
		UAR	:	Calcutta/Dumdum

2.357 SCHEDULE OF WEATHER BROADCAST FROM NAVAL WIRELESS STATIONS:

Table 2.65 gives the timings and frequencies of weather broadcasts from the naval wireless stations at Bombay and Visakhapatnam

Table 2.65

Weather broadcast scheduled from naval wireless stations

Station/Time	Call sign	Frequency (kHz)/ wavelength (m)
1. Bombay	VTG-3	2072/144.8
1500	VTG-4	4268/70.3
&	VTG-5	6467/46.4
2100	VTG-6	8634/34.7
	VTG-7	12808.5/23.4
	VTG-8	16938/23.4
	VTG-9	22378/13.4
2. Visakhapatnam	VTP-3	2295/130.7
0001 & 1600	VTP-4	4238/70.8
	VTP-5	6418/46.7
	VTP-6	8646/34.7
	VTP-7	12840/23.4

2.358 BROADCAST OF COASTAL BULLETINS BY P&T COASTAL RADIO STATIONS :

Table 2.66 gives the timing and frequencies of broadcast of coastal bulletins by P&T coastal radio stations.

Table 2.66

P&T coastal radio stations broadcasting coastal bulletins

State	Coastal radio	Frequency(kHz)/ Wavelength(m)	Timings(IST) Daily	Extra	Storm
Eastern Coast					
1. Andaman Group	Port Blair	442/678.7	0020 1520	0620	0320 1020 1920
2. Andhra Pradesh	Visakhapatnam	474/632.9	do	do	do
3. Tamil Nadu	Madras	515/582.5	do	do	do
	Tutticorin	487/616	do	do	do
4. West Bengal	Calcutta	470/638.3	do	do	do
Western Coast					
1 Goa	Goa	417.5/718.6	1350 2150	0450	0150 0950 1750
2. Gujarat	Kandala	40/681.8	do	do	do
3. Karnataka	Mangalore	438/684.9	do	do	do
4. Kerala	Cochin	460/579.1	do	do	do
5. Maharashtra & Goa	Bombay	518/579.1	do	do	do
	Ratnagiri	420.5/713.4	do	do	do

2.359 SCHEDULE OF WARNING BROADCAST BY AIR TO FISHERMEN :

Table 2.67 gives the schedule of warnings for fishermen broadcast by AIR.

Table 2.67

Schedule of warnings by AIR to fishermen

	State	Radio station	Timing	Frequency (kHz) Wave length (m)	Area covered	Language of Broadcast
1.	Andaman Group	Port Blair	0635, 0905, 1420, 1805, 1844, 2200, (Sunday-Friday) 2300 (Saturday)		Andaman Nicobar	Hindi
2.	Andhra Pradesh	Hyderabad	0609, 1328	738/406.5 3356/89.50 6096/49.02 7140/42.02 4800/62.05	Andhra Coast	
		Vijayawada	0654, 1445, 1904,	837/358.4	South Arcot	Telegu
		Visakhapatnam	0654, 1329, 1904	927/323.6	North Andhra coast	Telegu
3.	Goa	Panaji	0730, 1340	828/362.3	Goa coast	English Konkani
4.	Gujarat	Bhuj	0615, 1510, 1745	1314/228.3	North Gujarat coast	Gujrati
		Rajkot	0715, 1510, 1950	693/432.9	North Gujrat coast	Gujrati
5.	Karnataka	Bangalore	1430, 1934	612/490.2	Karnataka coast	Kannada
		Bhadrabati	1850, 1934	1359/220.8	do	do
		Dharwar	0650, 1850	1350/222.2	do	do
		Mangalore	1430, 2230	1458/205.7	do	do

	State	Radio Station	Timing	Frequency (kHz) Wave length (m)	Area covered	Language of Broadcast
6.	Kerala	Calicut	0624, 1410, 1919	576/438.6	Kerala & Lakshadwip	Malayalam
		Trichur	0720, 1410, 1855	630/476.2	do	do
		Trivandrum	0624, 1410 Sunday-1445 Saturday-1440	1161/258.4 1494/200.8	do	
7.	Maharashtra	Bombay	a)0715, 2330 b)1430-, 1530, 1805, 2310,)0645, 1340, 1800, 2310.	a)1188/252.2 b)1044/287.4 c)558/537.6	Maharashtra coast	(a) Hindi (b) English (c) Marathi
		Ratnagiri	0659, 1500, 2331, 2310	1145/262.4	Maharastra coast	Marathi
8.	Orissa	Cuttack	0635, 1805, 1820, 1930	972/308.6	Orissa Coast	Oriya
		Sambalpur	0635, 1805	945/317.5	do	do
9.	Pondicherry	Pondicherry	1755	1062/282.4	Tamil Nadu	Tamil
10.	Tamil Nadu	Madras	0639 1355 1848	720/416.7 7160/41.9 4920/60.98	Tamil Nadu	Tamil
		Tiruchirapalli	0605, 1230, 1805	936/320.6	do	do
		Tirunvelli	1445	1197/250.6	do	do

	State	Radio Station	Timing	Frequency (kHz) Wave length (m)	Area covered	Language of Broad-cast
11.	West Bengal	Calcutta	a) 0600, 0635	a) 657,456.6 4820,62.2	West Bengal coast	a) Bengali
			b) 1426	b) 657,456.6	do	b) Bengali English
			c) 1800	c) 657,456.6 4820,62.2	do	c) Bengali
			d) 2300	d) do	do	d) Bengali English

Appendix 2.15 The AIR network and Doordarshan Kendras in the coastal states

2.360 THE AIR NETWORK OF RADIO STATION IN THE COASTAL STATES[1]:

The Cyclone Warning Dissemination at present is mainly based on the Medium Frequency broadcasting stations of AIR which relays the News Cycle from Delhi on the Home Service. The News Cycle is also broadcast on Short Wave broadcasts, but these are not as reliable as the Medium Frequency broadcasts for the short wave frequencies have to be frequently changed depending upon the season and solar activities and sun sports densities and other factors which disturb the atmosphere. The medium frequencies are not perturbed by these factors.

2.361 MEDIUM FREQUENCY RADIO STATIONS IN THE COASTAL STATES :

Table 2.68 gives the network of Medium Frequency radio stations of the AIR in the coastal states. The radio stations are also shown in figure 2.52.

Table 2.68

AIR Medium Frequency Radio Stations in the coastal states

State	City	Frequency (kilohertz)	Wavelength (Meter)	Power (kilowatt)
1. Andaman Group	Port Blair	684	438.6	20
	do	1440	208.3	1

Locations : 1
MW Services : 2

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* Home programme wavelength schedule (2nd May - 4th Sept. 1982) Director General, All

State	City	Frequency (kilohertz)	Wavelength (Meter)	Power (kilowatt)
2.Andhra Pradesh	Adilabad	1548	193.8	(1)
	Cuddapah	900	333.3	20(100)
	Hyderabad-A	738	406.5	50
	-do- B	1377	217.9	10
	-do- C	1170	256.4	1
	Vijaywada-A	837	358.4	20
	-do- B	1503	199.6	1
	Visakhapatnam	927	323.6	100
	Locations : 5 MW Services : 7			
3.Goa	Panaji A	828	362.3	10
	-do- B	1539	194.9	5
	Locations : 1 MW Services : 2			
4.Gujarat	Ahmedabad-A	846	354.6	50
	-do- -B	1440	208.3	1
	Bhuj	1314	228.3	10
	Rajkot A	693	432.9	20(300)
	-do- B	1422	210.9	1
	Vadodara (Baroda)	1485	202	1
	Locations : 4 MW Services : 6			
5.Karnataka	Bangalore A	612	490.2	50
	-do- B	675	444.4	1
	Bhadrabati	1359	220.8	20
	Dharwar A	765	392.1	10(200)
	-do- B	1350	222.2	1
	Gulbarga	1107	271	10
	Mangalore	1458	205.7	1
	Mysore	1017	295	1
	Udipi	1089	275.5	20
	Locations : 7 MW Services : 9			
6.Kerala	Alleppy	576	520.8	100
	Kozhikode (Calicut)-A	684	438.6	10
	-do- -B	1431	209.6	1
	Trichur	630	476.2	20
	Trivandrum-A	1161	258.4	10
	-do- -B	1494	200.8	1
	Locations : 4 MW Services : 6			

State	City	Frequency (kilohertz)	Wavelength (Meter)	Power (kilowatt)
7.Maharashtra	Bombay A	1044	287.4	20
	-do- B	558	537.6	50
	-do- C	1188	252.8	20
	Jalgaon	963	311.5	20
	Nagpur-A	585	512.8	100
	-do- B	1602	187.3	1
	Parbhani	1305	229.9	10
	Pune-A	792	378.7	20(100)
	-do--B	1602	187.2	1
	Ratnagiri	1143	262.4	20
	Sangli	1251	239.8	20
	Sholapur			1
	Locations : 6 MW Services : 10			
8.Orissa	Cuttack-A	972	308.6	100
	-do- -B	1314	228.3	1
	Jeypur	1467	204.5	20
	Sambalpur	945	317.5	20
	Locations : 3 MW Services : 4			
9.Pondicherry	Pondicherry	1062	282.4	1
	Locations : 1 MW Services : 1			
10.Tamil Nadu	Coimbatore	999	300.3	10
	Madras-A	720	416.7	20(200)
	-do- -B	1584	189.3	1
	-do- -C	783	383.1	2.5
	Madurai	1215	246.9	(10)
	Nagercoil	1602	187.2	(1)
	Tiruchirapalli-A	936	320.6	50
	-do- -B	1602[1]	187.2[1]	1
	Tirunvelli	1197	250.6	10
	Locations : 5 MW Services : 9			
11.West Bengal	Calcutta-A	657	456.6	100
	-do- -B	1008	297.6	50
	-do- -C	1323	226.7	20
	-do- -D	1224	245.1	2.5
	-do- (Night)	1134	264.6	1000
	Mogra (Day)	594	505.1	1000
	Siliguri	711	421.9	20
	Locations : 3 MW Services : 7			

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* Due to be changed to 891 kHz/336.7m

State	City	Frequency (kilohertz)	Wavelength (Meter)	Power (kilowatt)
12.States near to coast Tripura Mizoram	Agartala	1269	236.4	20
	Aizwal	540	556.0	20
	Locations · 2 MW Services : 2			

2.362 THE SHORT WAVE RADIOSTATIONS IN THE COASTAL STATES

Table 2.69 gives the shortwave radiostations of the AIR in the coastal States. The stations are also shown in the map of figure 2.52.

Table 2.69

AIR Short Wave Radiostations in the coastal States

State	City	Time	Frequency (Megahertz)	Wavelength (Meter)	Power (kilowatt)
1.Andhra Pradesh	Hyderabad	1.Upto 0745 hr. evening,night	4.8	62.50	10
		2.After 0800 hr	7.14	42.02	10
		3.Afternoon, evening Night	4.92	61.98	10
2.Maharastra	Bombay	1.Upto 0745 hr, evening,night	4.84	41.44	10
		2.After 0800 hr	7.24	41.44	10
		3.Afternoon	9.55	31.41	10
3.Tamil Nadu	Madras	1.Upto 0745 hr, evening,night	4.92	60.98	10
		2.After 0800 hr	7.16	41.90	10
		3.Afternoon	9.575	31.33	10
4.West	Calcutta	1.Upto 0745 hr, night after 1800 hr	4.82	62.24	10
		2.After 0800 hr, after 1545 hr	7.21	41.61	10
		3.Afternoon	9.53	31.48	10
	Kurseong	1.Upto 0930 hr,	4.895	61.29	20
		2.Afternoon	7.23	41.49	20
		3.Evening,night	3.355	89.42	20

2.363 THE DOORDARSHAN KENDRAS IN THE COASTAL STATES :

Table 2.70 gives the Doordarshan Kendras in the coastal States which can be used for cyclone warning dissemination. The stations are also shown in the map of figure 2.52.

TABLE 2.70

DOORDARSHAN KENDRAS IN THE COASTAL STATES

State	City	Channel	Power (Kilowatt)
1. Andhra Pradesh	Hyderabad	IV	10
	Vijayawada	IX	(10)
2. Gujarat	Ahmedabad	VII	10
3. Karnataka	Bangalore	V	10
	Gulbarga	VII	10
4. Kerala	Trivandrum	V	(10)
5. Maharashtra	Bombay	IV	10
	Nagpur	VII	(10)
	Pune	V	0.6
6. Orissa	Cuttack	VIII	(10)
	Sambalpur	VII	1
7. Tamil Nadu	Kodaikanal	VII	(10)
	Madras	IV	10
8. West Bengal	Asansol	VII	(10)
	Calcutta	IV	10
	Murshidabad	X	(10)

Legend : (   ) = proposed

2.364 BROADCAST IN LOCAL LANGUAGES :

The News Cycle broadcasts in regional languages from AIR (AIR Home News Service) which is relayed in the medium wave and short wave broadcasts from local AIR stations are down thrice daily in the morning, afternoon and evening. The timings of these 10 minute broadcasts from the AIR stations in the coastal states are given in Table 2.71.

TABLE 2.71

Timings of broadcasts in regional languages of the coastal states

Language	Morning (M)	Afternoon (A)	Evening (E)
Bengali	0725	1330	1935
Gujrati	0745	1320	1950
Kannada	0735	1310	1935
Malayalam	0725	1250	1925
Marathi	0830	1330	2005
Oriya	0715	1320	1915
Sindhi	0840		1815
Tamil	0715	1240	1915
Telegu	0705	1230	1905

2.365 HOME NEWS SERVICE IN SHORT WAVE :

The Home News Service of AIR are broadcast from Delhi in shortwave in local languages. Table 2.72 gives the shortwave frequencies for the morning, afternoon and evening news service in the languages of the coastal states. The frequencies for the news service in English and Hindi have not been listed as they are too munerous. The broadcasts in the languages of the coastal states are far more important from the point of view of cyclone warring.

TABLE 2.72

Home Service in short wave in languages of the coastal states

Language	Frequency (Megahertz)/Wavelength (Meter) Morning	Afternoon	Evening
1. Bengali	9.545/31.43	9.615/31.20	7.255/41,35
	11.895/25.22	11.730/25.58	9.705/31.91
	15.125/19,83	15.285/19.63	9.950/30.15
2. Gujarati	9.615/31.20	9.560/31.38	3.925/76.43
	9.745/30.79	9.705/31.91	4.860/61.73
	11.830/25.36	11.850/25.32	
		11.935/25.14	7.280/41.22
3. Kannada	9.615/31.20	11.850/25.32	7.280/41.21
	11.830/25.36	11.935/25.14	10.335/29.03
	15.142/19.82	15.250/19.67	11.620/25.82
4. Konkoni			

Language	Frequency (Megahertz)/Wavelength (Meter)		
	Morning	Afternoon	Evening
5. Malyalam	9.615/31.20	11.850/25.32	7.280/41.21
	11.830/25.36	11.935/25.14	10.335/29.03
	15.140/19.82	15.250/19.67	11.620/25.82
6. Marathi	9.615/31.20	9.560/31.38	3.925/76.43
	9.745/30.79	9.705/30.91	7.280/41.21
	11.830/25.36	11.850/25.32	7.412/40.47
		11.935/25.14	9.950/30.15
7. Oriya	9.545/31.43	9.615/31.20	7.255/41.35
	11.895/25.22	11.735/25.56	9.705/31.91
	15.125/19.83	15.285/19.63	9.950/30.15
8. Sindhi	6.045/49.63		3.905/76.82
	7.225/41.52		7.280/41.21
	9.615/31.20		11.620/25.82
9. Tamil	9.615/31.20	11.850/25.32	7.280/41.21
	11.830/25.36	11.935/25.14	10.335/29.03
	15.140/19.82	15.250/19.67	11.620/25.82
10. Telegu	6.046/49.63	11.850/25.32	3.925/76.43
	9.615/31.20	11.935/25.14	7.280/41.21
	11.830/25.36	15.250/19.67	10.335/29.03
			11.620/25.82

Appendix 2.16 : Financial management of natural calamities

2.366 MARGIN MONEYS RECOMMENDED TO VARIOUS COASTAL STATES BY THE 7TH FINANCE COMMISSION :

Table 2.73 gives the margin moneys recommended to various coastal States by the 7th Finance Commission.' Though the table gives an idea of the disaster proneness of the various coastal states, it does not reveal to what extent the damages caused by cyclone disasters are repaired by these funds.

TABLE 2.73

Margin Money recommended to the various coastal states by the 7th Finance Commission

State	Amount in lakhs of rupees
1. Andhra Pradesh	858
2. Gujarat	956
3. Karnataka	200
4. Kerala	159
5. Maharashtra	457
6. Orissa	871
7. Tamil Nadu	859
8. West Bengal	1360

2.367 GUIDELINES FOR RELIEF MEASURES BY BANKS IN AREAS AFFECTED CALAMITIES[1] :

Certain guidelines have been given to banks for providing funds for relief measures after natural calamities. These are listed below :

1. Periodical but frequent occurrence of floods, cyclones, tidal waves and other natural calamities cause heavy toll of human life and wide-spread damage to economic persuits of human beings in one area or the other of our country. The devastation caused by such natural calamities call for massive rehabilitation efforts by all agencies. The State and local authorities drew programmes for economic rehabilitation of the affected people. The developmental role assigned to the commercial banks and co-operative banks, warrants their active support in revival of the economic activities.

2. Since the area and time of occurrence and intensity of natural calamities cannot be anticipated, it is imperative that the banks have a blue-print of action in such eventualities so that the required relief and assistance is provided with the utmost speed and without any loss of time. This pre-supposes that all the branches of commercial banks and their Regional and Zonal Offices will have a set of standing instructions spelling out the action that the branches will have to initiate in the calamity affected areas immediately after the requisite declaration by the district/State authorities. It is necessary that these instructions should also be available with the State Government authorities and all the District Collectors so that all concerned are clear as to the action that would be taken by the banks' branches in the affected areas-

3. The precise details in regard to the provision of credit assistance by the commercial banks, will depend on the requirements of the situation, their own operational capabilities and the actual needs of the borrowers. This can be decided by them in consultation with the district authorities.

4. Nevertheless, to enable banks to take uniform and concerted action expeditiously, particularly, to provide financial assistance to agriculturists, small scale industries units, artisans, small business and trading establishments affected by natural calamities, the following guidelines are recommended.

5. To facilitate coordination and expeditious action by the financing institutions the convenors of the concerned district consultative committees of the affected districts should convene a meeting immediately after the occurrence of natural calamities. In the event of the calamity covering a large part of the State, the convenors of the State level bankers committee will also convene a meeting immediately to evolve a coordinated programme of action for implementation of the programme in collaboration with the State/ district authorities.

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* [1] Information given to the Committee by Shri K.S.Chandrasekeren Special Relief Commissioner for Orissa.

6. Divisional/Zonal Manager of Commercial Banks should be vested with certain discretionary powers so that they do not have to seek fresh approvals from their Central offices to the line of action agreed to by the District/State Level Bankers' Committees. For example, such discretionary powers would be necessary in respect of adoption of scale of finance.

7. Identification of the beneficiaries :

The Bank branches should obtain from the concerned Government authorities lists of affected villages within their areas of operation. From among the identified persons, assessment of loss sustained by the existing constituents of the Banks would be easier. In the case of fresh borrowers, however, discrete inquiries should be made in this regard and assistance of the Government authorities should be sought wherever available for ascertaining genuineness of their requirement.

8. Coverage : Each branch will provide credit assistance not only to its existing borrowers but other eligible persons within its command area provided they are not covered by any other financial agency.

9. Credit requirements of the borrowing members of the Co-operatives will be met by the Primary Agricultural Cooperatives Societies (PACs)/LAMPS/FSS etc. Branches of commercial bank may however, finance the non-borrowing members of the cooperative societies, for which the latter will issue the usual No Objection Certificate speedily.

10. Priorities : Immediate assistance including finances would be needed for protecting and rejuvenating standing crops/ orchards plantations etc. Equally important will be repair and protection of livestock sheds grain and fodder storage structures, drainage pumping, and other measures and operations to repair pumpsets, motors engines and other necessary implements. Subject to seasonal requirements next crop financing would be taken up.

11. Agriculture : Assistance to farmers will primarily cover production. Finance for raising crops and term loans for purchase of milch/drought animals, repairs to existing tubewells and pumpsets, digging of new tubewells and installation of new pumpsets as well as for land reclamation. General terms and conditions in this regard will be as follows :

12. Crop loans : Existing crop loan dues in notified affected areas will be converted into term loans, repayable over a reasonable period. Overdues pertaining to last season and thereafter would be considered eligible for such conversions.

(a) For the purpose of conversion, a Certificate/ Notification issued by the District Magistrate or any other authority designated by the concerned State Government in this behalf to the effect that crops had failed or are destroyed in the area affected, would be adequate.

(b) Pending finalisation of conversion/rescheduling operations, which might take time, the eligible cultivators will be disbursed crop loans for the current as also ensuing seasonal operations.

(c) The rescheduling of the current crop loans will be done by the banks taking into account the loss suffered by the farmer and their repaying capacity. In the case of small and marginal farmers it may become necessary to schedule the first instalments of the converted loans in such a manner that the farmers have a reasonable time to recoup their losses and stabilise their operations.

To be effective, the assistance to farmers will have to be disbursed with utmost speed For this purpose the lead bank and the district authorities concerned should evolve a procedure whereby identification of borrowers, issuance of certificates regarding Government/cooperative bank dues, title of the applicant to land etc. is secured simultaneously Possibilities of organising credit camps where Block Development and Revenue officials, Cooperative Inspectors, Panchayat Pradhans etc. could help to finalise the applications on the spot could be explored in consultation with the district authorities. Where such credit camps are being organised, the State Government will also arrange with the Collectors to issue an executive order for the following officers of their authorised representatives to assume respective duties and responsibilities as envisaged under implementation of credit camps programme.

(a) Block Development Officer
(b) Cooperative Inspector
(c) Revenue Authority/Village Revenue Assistant
(d) Bank official operating in the area
(e) PAC's/LAMPS/PSS
(f) Gram Panchayat Pradhan

In order to avoid delay, the forms in which the State Government Officers have to give certificates at the credit camps may be got printed in sufficient numbers by the respective district magistrates.

13. In considering loan applications for the ensuing crop season the current dues of the applicants to the State Government may be ignored, provided the State Government declares a moratorium for a sufficiently long period on all amounts due to the Government as on the date of occurrence of the natural calamity.

14. Scale of Finance : Scale of Finance in respect of different crops will be uniform in a district. The scales be fixed taking into account the prevailing conditions and norms presently adopted by different lending agencies. In fixing the scales, minimum consumption needs of borrowers will be taken into account. The concerned District Magistrate and Managers of branches of banks operating in the district would be advised to adopt the scale so laid down.

15. Development Loans : Like the crop loans, existing term loans instalments will have to be rescheduled keeping in view the repaying capacity of the borrowers.

16. Apart from rescheduling existing term loans, banks will provide to affected farmers diverse type of term loans for developmental purposes, such as :

(a) Minor Irrigation : Term loans for repairs to wells, pumpsets, etc. which are to be quantified after assessing the extent of damage and estimated cost of repairs.

(b) Bullocks : Where the drought animals have been washed away, requests for fresh loans for a new pair of bullocks may be considered. Where loans are given for purchase of new cattle or where farmers have brought milch cattle, reasonable credit may be given for purchase of fodder or feed.

(c) Milch cattle : Term loan for milch cattle will be considered depending upon bread, milk yield, etc. The loan amount will include repairs to shelters, purchase of equipments and feed.

(d) Insurance : Considering the proneness of areas to cyclone and other natural calamities, the cattle should be insured instead of Risk-cum-Mortality Fund established for similar purposes in other safe areas. Milch animals/drought cattle should be branded for identification as also to serve as a safeguard against their re-sale by the beneficiaries.

(e) Poultry and Piggery : For poultry, piggery and goatery loans will be considered as per norms of different banks.

(f) Fisheries : In the case of borrowers who have lost their boats, nets and other equipment, rephasing of payment of existing dues may be allowed on merits. Fresh loans may be granted to them with loan maturity of 3-4 years. Loans for repairs to boats of the existing borrowers may also be considered. In cases where subsidy is available the quantum of loan should be reduced to that extent. In States where substantial subsidy towards the cost of boats, nets etc. is likely to be available, proper coordination with the concerned State Government Department in this regard must be ensured. Apart from complying with other norms and conditions for grant of advances, assistance may be sought from the Department of Fisheries, which may be expected to take measures for this purpose. The boats should be comprehensively insured against all risks including natural calamities as far as possible.

17. Land Reclamation : It is likely that financial assistance will be required for reclamation of lands covered by sand casting. Normally, sand/slit deposits upto 3 inches will either be ploughed back into the soil or removed by the farmers without any need for financial assistance. Loan applications will, however, be considered in cases where immediate cultivation is possible, and reclamation (removal of sand) is necessary. Wherever reclamation finance for saline lands is warranted, the cost of reclamation not exceeding 25% of the scale allowed for crop loan may be advanced alongwith the crop loan.

18. For other activities like Sericulture, Horticulture, Floriculture, Betelvine growing etc. banks will advance loans for investment and working capital under their existing scheme and follow usual procedure laid down by them.

19. However, additional need based crop loans if necessary would be given for revitalisation/rejuvenation of standing crops/orchards based on individual assessment.

20. The question relating to procurement and proper arrangement for supply of adequate quantity of seeds and various types of fertilisers will have to be discussed with the State Government and District Administration in each district. Similarly, for the purpose of ensuring adequate irrigation facilities, the State Government will undertake repairs to Government owned shallow and deep tubewells and River Lift Irrigation System damaged by Floods and other natural calamities. As for fisheries, the fisheries department of the State Government will make arrangement to obtain fingerlings/ and supply them to those who wish to revive tank fishing with bank finance.

21. Agriculture Refinance and Development Corporation (ARDC) should consider assistance to borrowers of commercial banks under ARDC scheme for the above purpose. The State Government will have to consider preparation of schemes which would enable commercial banks to obtain refinance at ARDC rates for amount advanced by them for the said purpose.

22. Consumption loans : In view of the damage to crops and property, existing borrowers need consumption loans for sustenance till the flow of income is resumed. For this purpose Rs. 75/- is admissible for general consumption. In view of the special situation obtaining in the affected areas and the need for consumption loan for general purposes, the banks may extend for general consumption loan upto the harvesting of the current or the next crop depending on the devastation caused by the natural calamity on proper assessment in individual cases.

23. Artisans and self Employment: For all categories of rural artisans and self employed persons including handloom weavers, loans will be needed for repairs of sheds, replacement of implements and purchase of raw materials and stores. In sanctioning the loan, the due allowance will be made for subsidy/assistance available from the concerned State Government.

24. There may be many artisans, traders and self-employed who may not have any banking arrangement or facility with any banks but will now need financial assistance for rehabilitation. Such categories will be eligible for assistance from banks branches in whose command are as they reside or carry on their professions/ business. Where such a person/party fails under the command area of more than one bank, the banks concerned will meet together and sort out his problem.

25. Small Scale and Tiny Units : Rehabilitation of units under village and cottage industry sector, small scale industrial units as also smaller of the medium industrial sector damaged, will also need attention. Term loans for repairs to and renovation of factory buildings/sheds and machinery as also for replacement of damaged parts and working capital for purchase of raw materials and stores will need to be provided urgently.

26. Where the raw materials or finished goods have been washed away or ruined or damaged, banks' security for working capital will naturally be eroded and the working capital account (cash Credit or Loan) will be out of order. In such cases, banks will convert drawings in excess of the value of security into a term loan and also provide further working capital to the borrowers.

27. Depending on the damages suffered and time needed for rehabilitation and restarting production and sales, term loan instalments will have to be suitably rescheduled keeping in view the income generating capacity of the unit. Shortfall in margin will have to be condoned or even waived and borrower should be allowed time to build up margin gradually from his future cash generation. Wherever State Government or any agency has formulated special scheme for providing grants/subsidy/Seed money, suitable margin may be stipulated to the extent of such grants/subsidy/Seed money.

The primary consideration before the banks in extending credit to a small/tiny unit for its rehabilitation should be the viability of the venture after the rehabilitation programme is implemented.

28. Special refinance facility (SRF 1979) introduced by IDBI for providing full refinance to banks on soft terms will be availed of, during the period of its validity. In this connection, reference may be made to their circular letter No.7478/RD Pro.(14)-78/79 of 24th May, 1979.

29. Terms and Conditions : The terms and conditions governing relief loans will be flexible as to security, margin, etc. In the case of small loans covered by guarantees of Deposits Insurance and Credit Guarantee Corporation and Credit Guarantee Organisation, personal guarantees will not be insisted upon. In any case credit should not be denied for want or personal guarantees.

30 Security : Where the Banks' existing security has been ordered because of damage or destruction by floods assistance will not be denied merely for want of additional fresh security For fresh loans sympathetic view will have to be taken.

(a) Loans to land owners, assignees of vested land and share-croppers will be secured by a charge on the land through a declaration in terms of the concerned State Agricultural Credit Operations Act. For loans, not exceeding Rs.5,000/- per borrowers, production of Not Encumbrance Certificate should not be insisted upon provided No Dues Certificate is obtained from Cooperative and the State Government have declared a moratorium on the recovery of their loans.

(b) In the absence of original Title Records, a Certificate issued by the Revenue Department Officials will be accepted for financing farmers who have lost proof of their titles i.e. in the form of deeds as also the registration certificates issued to registered share-croppers.

(c) In the case of term loans for replacement of equipments, repairs, etc. and for working capital finance to artisansand self employed persons or for crop loans, usual security may be obtained.

(d) As per the recommendations of the RBI report on customer service banks will finance the borrowers who require loans upto Rs.500/- without insisting either on collateral security or guarantee for any type of economic activity.

31. Margin : Margin requirements in the case of loans for wells/pumpsets as also replacement finance provided to handloom weavers and other small borrowers, will, if necessary be waived or the grants/subsidy given by the concerned State Government may be considered as margin.

32. Interest : The rates of interest will be in accordance with the directives of the Reserve Bank. Within the area of their discretion however, banks are expected to take a sympathetic view of the difficulties of the borrowers and extend a concessional treatments to calamity affected people. These meeting the eligibility criteria under the scheme of differential rate of Interest should be provided credit in accordance with the provisions of the Scheme In respect of current dues in default, no panel interest will be charged. The banks should also suitably defer the compounding of interest charges.

Appendix 2.17 : Building code for cyclone proof building/houses

2.368 INDIAN STANDARD CODE OF PRACTICE FOR STRUCTURAL SAFETY OF BUILDINGS [1] :

The Indian Standard Code of Practice was originally published in 1957 for guidance of civil engineers designers architects and others interested in building designs. The Code was revised and adopted by the Indian Standards Institution in 1964 after the draft finalised by the structural safety Sectional Committee (SSSC) was approved by the Building Division Council. The revision incorporates certain important modifications/additions which are revisions of the provisions regarding basic wind pressure and its effect on buildings : new clauses on wind load for butterfly type structures, modified wind pressure coefficients for sheeted roofs (curved/sloping) and deletion of seismic load provisions since a separate and comprehensive code was prepared for it.

2.369 WIND MAPS FOR INDIA :

For purposes of building designs considerations must be given to various types of loading requirements

1) Dead loads : This comprises the weight of all walls/ partitions/floors/roofs and shall include the weights of all other permanent constructions in the building.

2) Live loads : Live loads on floors include all loads other than dead loads. Live loads on roofs may be caused by snow/rain and other causes. A part of the live load may be caused by impact/vibrations.

For purposes of designing for protection against cyclones it is important to allow for wind loads which are essentially wind pressures depending on wind velocities. Wind loads are of two kinds as caused by -

1) winds of short duration i.e. whose maximum speed reach suddenly lasting for a few minutes.

2) Steady winds

The response of a structure to wind depends not only on its own characteristics and those of wind flow but also on the duration of the wind. To understand the effect of short bursts of winds on structures it is necessary to understand also the response to the various intensities of the various frequency components of the wind bursts. Such studies remain to be done in detail. The SSSC in consultation with the IMD prepared two maps(figures 2.53 and 2.54) which in absence of more detailed information must

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* 1 Indian Standard Code of Practice for Structural Safety of Buildings(Loading Standards) - Revised: Indian Standard Institution UDC 69.042 (1965) Reprint (1982).

serve the building designers working in the coastal areas. At present no detailed guidance from the SSSC exists to indicate which of the set of data in fig. 2.53 or fig. 2.54 has to be used in a particular situation. SSSC recommended that under the circumstances the required information as given in fig. 2.53 is to be preferred. This may be alright for the coastal regions for the classification of wind prevailing over the various parts of it in the two figures 2.53 and 2.54 apparantly correspond and considerations have been given to wind speeds obtained in cyclonic situation. In the inner regions of the India the maps show that short bursts can rise upto 111.8 kmph in some regions and 124.2 kmph in others. The basic equation relating wind pressure to wind velocity is

$$p = KV^2$$

where p = wind pressure (kg/m^2), V = wind velocity (km/hr) and K a coefficient usually taken as 0.006. For high buildings it is required to estimate the wind pressures at various heights above the main retarding surface. Table 2.74 gives the pressures at the various heights for winds of short duration lasting a few minutes as also for steady winds.

TABLE 2.74

Wind pressure for various heights over the main retarding surface for short duration/steady winds.

This table corresponds to figures 2.53 and 2.54 corresponding to winds of short duration and steady winds respectively.

Region Fig. 2.53	Marking Fig. 2.54	Wind Velocity (kmph)	Pressures (Kg/m^2) at various heights on the main retarding surface (m)												
			0-	10 -	30	35	40	45	50	60	70	80	100	120	150
	I	86.60	45	45	60	62	63	65	67	69	71	73	76	79	83
I	II	111.8	75	75	100	104	105	108	111	115	118	122	127	132	138
II	III	124.2	92.5	92.5	150	156	158	163	167	172	177	183	191	198	207
III	IV	158.1	150	150	200	208	210	217	222	230	236	244	254	264	276

Note: Figures to be used for stability calculations/designs of frame work/cladding.

Figures to be used for stability calculations/design of columns only.

For intermediate heights linear interpolation recommended.

2.370 WIND LOAD ON BUILDINGS :

The effect of wind on a building must be calculated on the basis of the basic wind pressure given in tables 2.74 and 2.75 corresponding to h, the height of the building and any projection thereof having due regard for the level of the main retarding surface and variation of wind pressure with height. For calculations due regards must be given to shape factors and internal air pressures. The following ratio R is important for categorisation of the calculations :

$$R = \frac{h}{a}$$

where h = height of the building

a = width of the base

The various recommendations are given hereunder :

1. Dependence of wind load factor on shape factor : For structures of various plan shapes other than rectangle plan shape, the external pressures acting on the projected area in the plane perpendicular to the wind is the product of the basic pressure described in paragraph 2.369 and the factors given in table 2.75.

TABLE 2.75

Shape factors for wind loads on building

Plan Shape		R	
	0-4	4 - 8	8
1. Circular	0.7	0.7	0.7
2. Octagonal	0.8	0.9	1.0
3. Square (wind perpendicular to diagonal)	0.8	0.9	1.0
4. Square (wind perpendicular to a face)	1.0	1.15	1.3

The stability calculations of a building should be based by considering the combined effect as also the separate effects of imposed loads and wind loads on vertical surfaces, roofs, any part of the building above the general roof level. Some relaxation may be given when the building is adequately stiffened by walls/floors/on except in regard to wall panels/roofs/foundations -

a) a building/part of building for $R \leq 2$

b) a section adjoining two parts of adequately stiffened building if $R \geq 2$ but length of the section $\leq 4a$

c) a wind if its projection length ≤ 2 its own width

2. Internal wind pressure : Internal wind pressure in a building depends on the degree of permeability of the cladding to air flow. The internal pressure may be positive or negative. Four cases come up for consideration:

a) Small permeability : If the air flow through the cladding is negligible as in multistoried buildings with panelled walls and no openings, internal pressure may be neglected

b) Normal permeability : The cladding permits flow of air but there are no large openings. An internal positive pressure i.e. suction of 0.2p acting normal to the wall/roof surface should be considered in addition to external wind pressures.

c) Building with large opening: If the openings are larger than 20% of the wall area as in hangers/shades an internal positive pressure or suction of 0.5p normal to wall/roof surfaces should be considered in addition to external wind pressures. This consideration applies to buildings with one open side.

d) Open type building : If the buildings have roofs but no walls, the roof is subjected to pressures from both outside and inside and special recommendations have been given to take care of these cases.

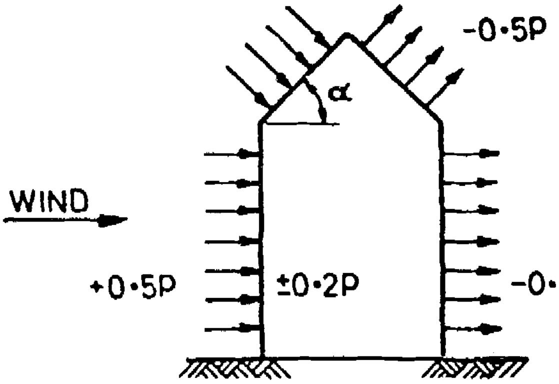
2.371 WIND LOAD ON STRUCTURAL FRAMEWORKS :

Wind loads on structural framework such as rigid frames, trusses resting on walls/columns need consideration also. In arriving at the wind loads only the average values of pressures for walls and roofs as given hereunder need be considered and no account need be taken of the local effects. The resultant wind loading on a structural frame work should be arrived at on the basis of average values of pressures simultaneously acting on the structures having due regard to the wind direction. The following items need careful consideration.

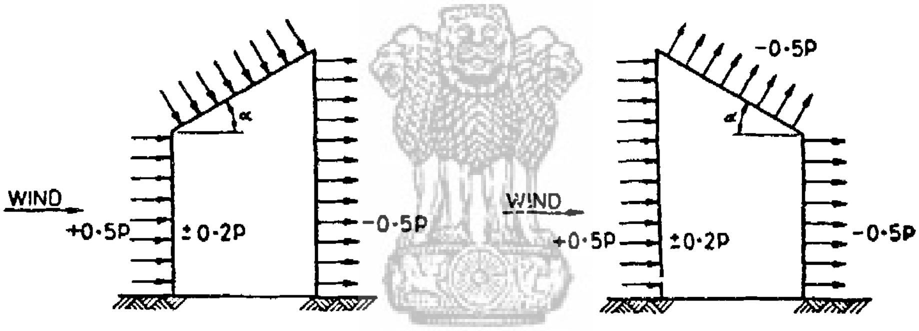
1. Wind drag on roofs : The effect of wind drag on roof may be taken at -

a) 0.05p measured on the plan area of the roof when the wind direction is normal to the ridge.

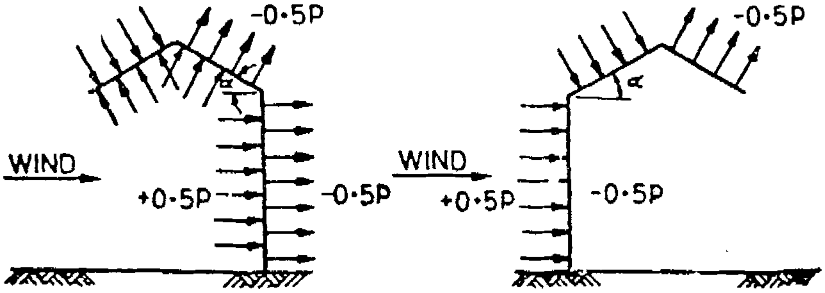
b) 0.025p measured on the total roof area ignoring openings when the wind direction is parallel to the ridge.



Building with Gable Roof and Normal Permeability



Building with Lean-to-Roof and Normal Permeability



Building Open on One Side or with Large Opening on One Side

Fig.2.55 Wind load on different types of flat roof. Reference 80

For walls the wind drag can be taken to be 0.025p when the wind is parallel to the wall and wall openings can be ignored.

2. Wind pressure on walls : The external wind pressure on a wall which is perpendicular to the wind direction may be considered as consisting of two parts :

Open walls :

a) an average positive pressure of 0.5p on the wind-ward face.

b) an average suction of 0.5p on the leeward face.

A wall exposed to wind on both sides would therefore be subjected to total average pressure p acting in the direction of the wind. When the walls form an enclosure the internal pressure has also to be considered :

Walls forming an enclosure : The walls should be sufficiently strong to stand up to a total average pressures, internal and outward, of

a) 0.5p for buildings of low permeability
b) 0.7p for buildings of normal permeability
c) p for buildings with large openings and walls exposed on both sides to winds.

These recommendations can be easily understood from a study of fig. 2.55. Some times the average values given above may be exceeded locally. On designing individual wall panels/wall sheetings due account can be taken of these local effects by increasing the values specified by 0.1p.

3. Wind pressure on roofs : The design of the roof should depend on the average wind pressures depending on various shapes as given hereunder and the internal air pressure -

A) Average roof pressure

a) Flat and pitched roofs: For flat and pitched roof the wind pressures normal to the surface due to wind blowing at right angles to the ridge is given in table 2.76 in terms of the basic pressure p.

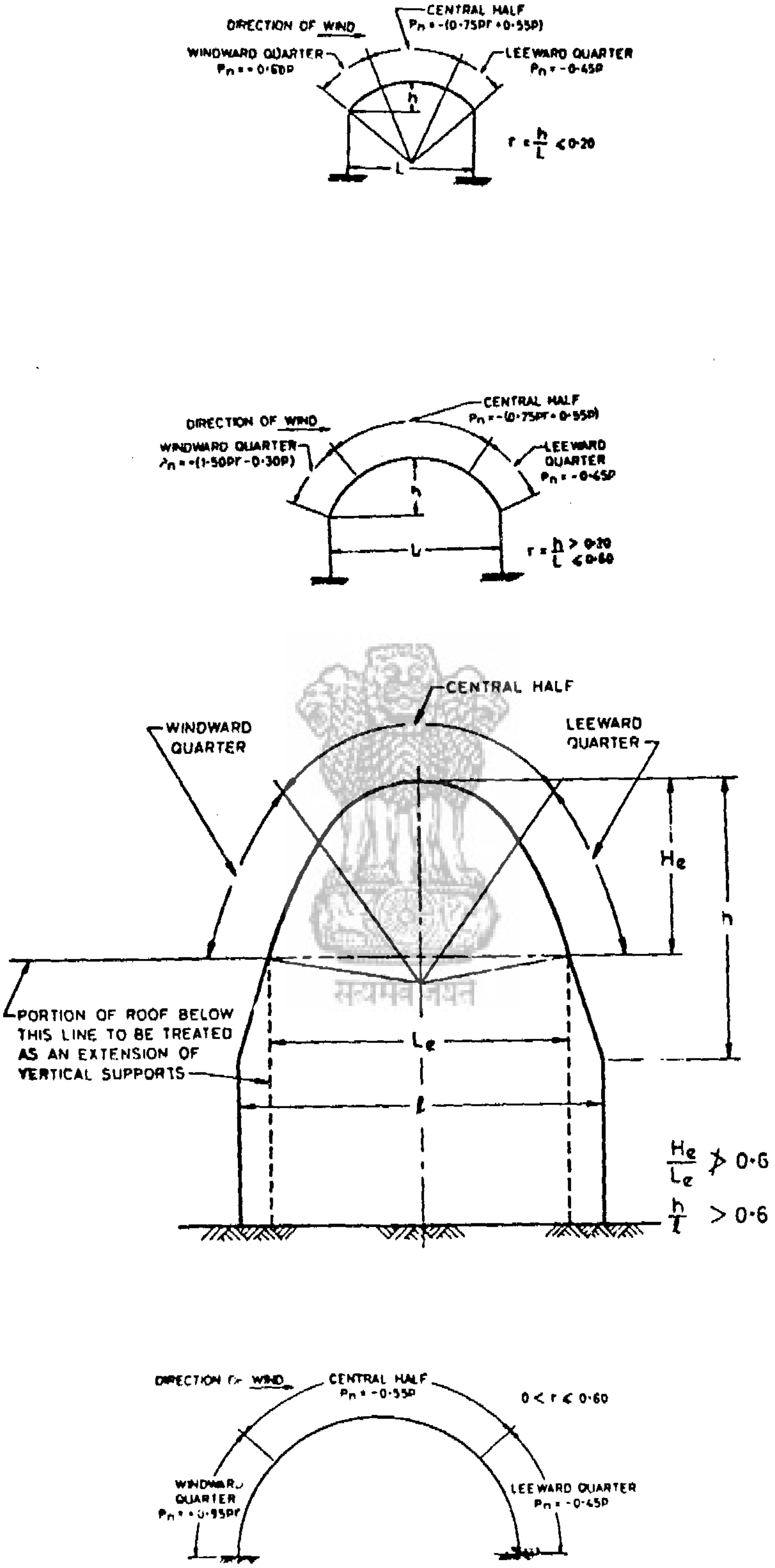


Fig.2.56 : Distribution of wind loads on a single curved roof. Reference 80

TABLE 2.76

Wind pressure on roofs for wind flow normal to the ridge

Slops of roof on windward side (in degrees)	External Wind pressure Windward slops	 Leeward slops
0°	-1.00p	-0.50p
10°	-0.70p	-0.50p
20°	-0.40p	-0.50p
30°	-0.10p	-0.50p
40°	+0.10p	-0.50p
50°	+0.30p	-0.50p
60°	+0.40p	-0.50p
70°	+0.50p	-0.50p
80°	+0.50p	-0.50p
90°	+0.50p	-0.50p

Legend : means positive pressure on the roof normal to its surface

- means external suction on the roof normal to its surface.

Interpolation is recommended for intermediate angles. For flat roof windward slope means windward half and leeward slope means the leeward half of the wind.

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b) Special type of roof structures: The following ratio is useful for making the recommendations :

$$r = \frac{h}{l}$$

where h = rise, l = span

If the structure is singly curved and on elevated supports the distribution of normal pressure P_n are

i) $r < 0.20$
Windward quarter: P_n = +0.60p
Central half : P_n = +(0.75+0.55)p
Leeward quarter : P_n = -0.45p

ii) $0.20 < r < 0.60$
Windward quarter: P_n = +(1.50+0.30)p
Central half : P_n = +(0.75+0.55)p
Leeward quarter : P_n = -0.45p

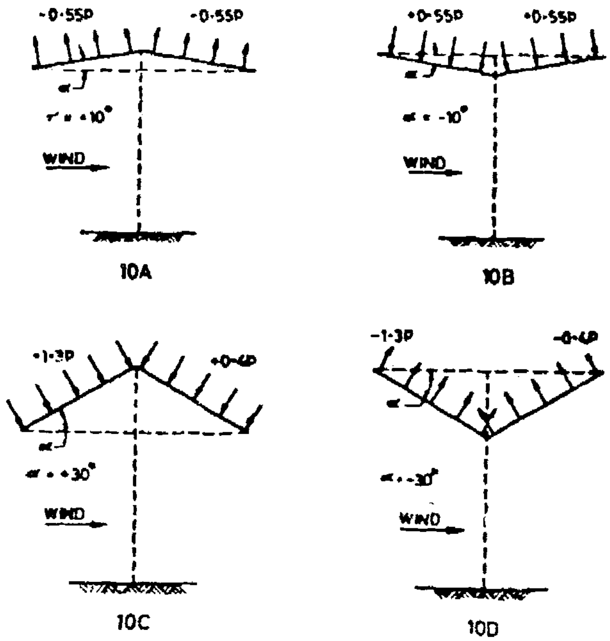

Fig.2.57 : Distribution of wind load on butterfly type roof. Reference 80

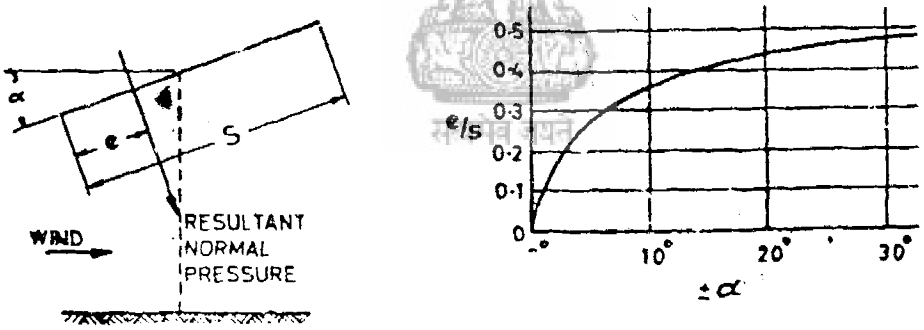

Fig.2.58 : Distribution of wind load on an independently stabding lean to roof. Reference 80

iii) $0.60 < r < 1$

Over the section of the roof where $r \geq 0.6$ the pressure distribution is as in (ii) above. This defines a rise h_e and span l_e such $h_e/l_e \leq 0.6$. Over the remaining section of the roof near the springings below $r = 0.6$ the pressure distribution is

Windward slope : $P_n = +0.95p$
Leeward slope : $P_n = -0.5p$

For the round surfaces resting on ground the distribution of P_n will be as under (iv)

If the singly curved structure rests on ground (fig. 2.56) then the distribution of normal pressure P_n are

Windward quarter: $P_n = +0.95p$
Central half : $P_n = -0.55p$
Leeward quarter: $P_n = -0.45p$

c) Doubly curved surface: The pressure at any point is $P_n = P \sin \phi$ where ϕ = angle between wind direction and direction to the tangent to the surface

d) Butterfly structures: Table 2.77 gives the distribution of P_n as function of α the angle of rise.

TABLE 2.77

Distribution of P_n on Butterfly Roofs

Angle of rise (in degrees) α	Windward	Leeward
-30°	$-1.3p$	$+0.55$ $-0.4\ p$
-10°	$+0.55p$	$+0.55p$
10°	$-0.55p$	$-0.55p$
30°	$+1.3\ p$	$+0.4\ p$

Interpolation may be made for intermediate angles.

e) Independently standing lean to roofs : For this type of roofs as are met with in pabilion roofs. This must be calculated from

$$W = p \sin \alpha$$

where α is the angle of rise. The position of the resultant pressure is given in fig. 2.58.

f) Multispan roofs : On the windward slope of the windward span and the leeward slope of the leeward span the pressures given for flat inclined roofs in table 2. apply. On other roof slopes only wind drag need be taken into account.

g) Wind blowing normal to gable ends : The average external wind pressures for such winds on the roof can be taken as

0.6p on both slopes of the roof over a length from the gable end equal to mean height of the roof from surrounding ground level

-0.4p over the remaining length of the roof on both slopes.

To take into account local effects the values given above should be increased by 0.31. All fastenings for roof sheetings should be capable of pressures exerted on sheeting after allowing increase for local effects. Fastenings within a distance 15 of the length of the roof from the gables should be capable of resisting a suction of 2p on the area of roof sheeting they support.

2.372 NEED FOR REVISION OF THE SSSC BUILDING CODE FOR WIND LOADS TO ACCOMODATE CYCLONE REQUIREMENTS :

The east coast is visited by very severe cyclones quite frequently each year and these storms last for quite some time and may have fluctuating velocity components. For a suitable cyclone code for buildings in the CPARs it is necessary to know first the wind distributions over the CPARs over long periods of time and the response of structures of various types of design/constructions to winds of such magnitude. In this respect the Building Code of SSSC discussed above needs review and revision. Moreover no allowance is made for the accompanying storm surges which may come upto levels of 5m on occasions. There is therefore need for the Indian Standard Institution to lay down a building code especially for cyclones and severe cyclones which should be put into operation rigorously in a 20 km belt on the coastal regions of the CPARs.

2.373 NEED FOR A CYCLONE BUILDING CODE FOR LOW COST HOUSINGS-HUTS AND SIMILAR CONSTRUCTIONS FOR POORER SECTION OF THE COMMUNITY :

Evidently the code discussed so far is suited for permanent structures and quite inapplicable for the semi-permanent dwellings of the poorer sections of the community. It is a remarkable fact that the traditional huts in Andhra Pradesh, Orissa and West Bengal with their high rise thatched roofs stand up very well to cyclonic winds. It may therefore be possible to combine the traditional practices of constructing such housings with modern technology to evolve a suitable dwelling place for the poorer sections of the coastal population. The guiding principles should be -

1. To use much of the traditional materials as possible mud plasters for walls, palm leaves/grass for roof cladding.

2. To retain the traditional shapes which have stood the test of time against cyclones

3. To limit the cost of repair/reconstruction within limits which the poorer section can bear

4. To evolve easy ways of strong reinforcements of the roofs and walls which can be employed by these people themselves.

5. To evolve ways of anchoring these dwelling houses firmly to the ground.

6. To consider whether steel/aluminium modular structures can be used as the basic frames for these dwellings to which roofs/walls can be easily attached. This would facilitate reconstruction of ruined dwellings.

The various Building Research Institutes should study the problem of these dwellings and evolve suitable designs for the poorer sections of the community living in the CPARs.

2.374 THE WORK DONE BY APPROPRIATE RECONSTRUCTION TRAINING AND INFORMATION CENTRE (ARTIC) OF ANDHRA PRADESH AND TAMIL NADU GOVERNMENT :

After the 1977 Andhra Pradesh Cyclone the ARTIC studied the problem of traditional dwelling houses for poorer sections of the community in coastal Andhra Pradesh and has made some recommendation[1] for structural improvements in them in Krishna and Guntur districts to make them stand out better against cyclones. The main finding and recommendations of ARTIC are as hereunder :

1. Features of traditional houses for poorer sections of the community : Usually these are timber framed post and beam structures with the posts buried in ground. The roof is bamboo framed with claddings of palmyra leaves with or without straw covering. The walls are either palmyra leaves on light bamboo frames fixed between posts or by wattle and daub constructions, which are mud plustered on each side of a light timber or bamboo frames. Fastenings of main joints are secured by nails and coconut fibre ropes are used for minor joints.

2, Ensurement of resistence against winds : The houses are made rigid by cross bracing. All the various components of the houses are tied together so that the whole frame from the roofing to the footing is firmly anchored to the ground.

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* 1 Recommendations for structural improvements to the traditional house : ARTIC Vijayawada Andhra Pradesh (1979).

3. Usual reasons for failures . There are three basic reasons for collapse of traditional houses.

a) Wall failure : Strong wind pressures on the roof and the walls are transmitted to the main posts leading to their failure due to insufficient strength or because they are not secured sufficiently deep in the ground to prevent the house from leaning over, or twisting and finally collapsing.

Recommendation : It is recommended that diagonal cross bracing should be fixed between posts of all walls and across each corner at top beam level. The bracing should be class 1 seasoned bamboo or timber of minimum 5 cm diameter nailed securely to posts or beams with 7.5cm galvanised nails and tied with 20 gauge galvanised wires. It is important to ensure that the bamboo/timber bracings do not split. If there is chance of splitting, then holes should be drilled before nailing.

b) Joint failure : The wind pressures on the roof are transferred from the bamboo roof framing to the horizontal beams which in turn transmit the load to the posts and joint connections. Traditionally the post-beam connection is nailed and tied with coconut fibre rope. The roof is secured to the beam by coconut fibre rope only. It has been seen that coconut ropes while initially strong is susceptible to decay under attacks by insect/wet rot because they are of organic materials. Nails connecting beams to posts are fixed into the end grains of timber post and are of little value in holding the roof down. They do however give good resistance to lateral/sideways forces.

Recommendation : The bamboo roof framing should be fixed to horizontal timber beam with 7.5 cm nail and also tied with minimum 20 gauge wire. Beam to beam and beam to post fixation should be carried out with 15 cm nails. In addition beams should be held down to the corner posts with two 2 cm wide x 90 cm long 24 gauge galvanised steel straps. The straps should be taken over the beams at the corner and down the sides of the post, pulled tight and fixed to the post with three 5 cm from the end of the post to prevent the post from splitting. At the intermediate post one strap should be used when a bearing plate is used at the top of the centre pole or when a ridge beam is used between two centre poles, they should be fixed to the poles with one strap. Galvanised sheet steel may be used from pickings from wastes from Agro machine shops in most towns. The alternative is to use steel packing case straps or large metal containers beated down flat and cut into suitable strips. The steel straps should be painted with tar to make them last longer

c) Post failure : The strong wind forces on roof/walls are finally transferred to the ground. The part of the posts under ground decay under attack from insects/wet rot and tend to break at the ground level leading to total collapse of the house.

Recommendation : Well seasoned timbers should be used for posts. Each post should be treated for resistance against termites by removing all the bark from the post and burning that part of the post which is buried to form a thin charcoal layer at that end. The posts should be painted with a thick coat of tar over the charcoal or soaking the end with sump oil for protection against wet rot. Alternatively the ends of the post can be soaked for 24 hrs in creosote to retard termites and wet rot. It is recommended that the posts should be buried 90 cm deep in the ground.

d) Roof : Generally the roofs remain intact even if blown away or if the walls collapse. The reasons is the structural efficiency of the steep angled pyramid shape and the close net work of vertical and horizontal bamboo framings. The palmyra leaves tied to the roof frames with coconut fibre ropes may be blown off in strong winds. This method of fastening is however recommended as it is convenient allowing easy replacements, which become necessary after every two years.

e) Prevention against pulling up of the house from the ground :

Recommendation : Two 7.5 cm diameter 60 cm long timber pieces should be fixed to the posts at distances 15 cm from the bottom of the posts at right angles to each other with 15 cm nails. These cross pieces should also be treated against insects and wet rots.

f) Prevention against humidity/rainwater

Recommendation : The floor levels may be raised well above the surrounding levels. This helps to keep the ground round the posts firm which is necessary to resist wind forces.

g) Resistance against wind

Recommendation : The mud walls should be made thicker than what is normally done to resist strong winds and stop them from collapsing. A window should be put on the back wall to relieve the internal pressure. Trees and bushes should be planted around the houses for protection against wind

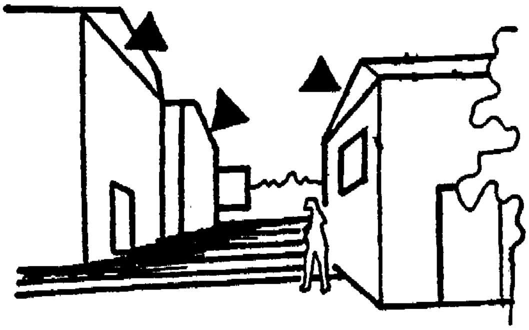
The houses should not be put in a straight line as all houses are then exposed to the wind. The wind is funnelled between rows of houses resulting in increase of wind speeds. If the houses are randomly placed, the houses on the outskirt of the village protect other houses.

Site

1. In locating a house take advantage of natural windbreaks such as stands of trees, small hills or hedges to reduce the impact of prevailing winds.

2, Be especially carefull of sites on or near tall hills. These can increase wind speeds by as much as 50 per cent

3. Valleys funnel winds; they can create abnormally high wind speeds. Consult an engineer or weather station official before building on such a site.



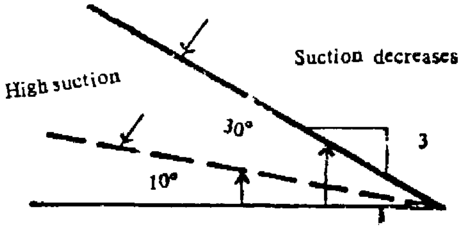
4. Buildings placed near one another can affect wind speeds. Intense suction can develop on the gable ends of pitched roofs. If the building is in the wake of another, expect turbulence and some high local loading on small elements such as cladding. Be sure these elements are securely Fastened.

5. When building a windbreak or shield, such as a row of trees or a wall, include small gaps to stabilize the flow on the lee side.

Fig.2.59 : Guide lines by Tamilnadu Government to builders of cyclone proof houses : selection of site and shape : Reference 102

SHAPE of the Building

6. Aim for roof pitches that approach 30 degrees (or about 1 m in 3). Wind loads are severe when roofs are pitched around five to ten degrees.



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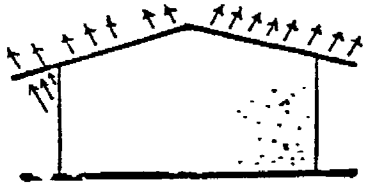
7. Avoid outside overhangs of more than 0.5 m, even if supported at the edge by columns. If unavoidable consider vents or louvers to relieve the upward pressure.



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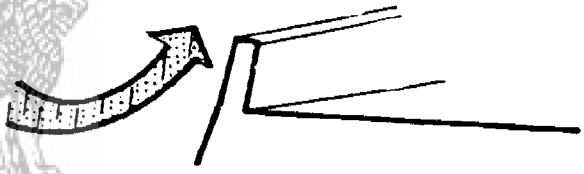
8. A parapet around a roof can reduce high suction along roof edges, but do not expect it to significantly reduce overall roof uplift.



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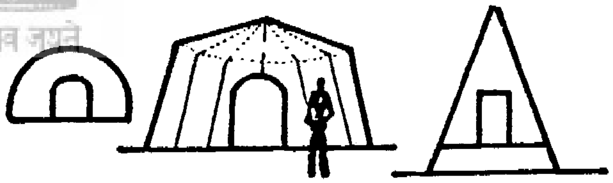
9. Consider round or polygonal shapes as these often reduce wind pressures. Similarly, certain structural systems, such as the A-frame, provide great stiffness.



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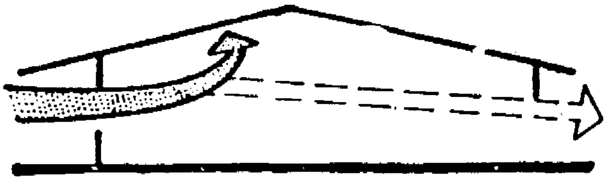
10. Avoid openings that cannot be closed off during hurricanes. High winds penetrate the building and create high outward pressures on walls and roof. If a broken window admits high wind, arrange for openings on opposite walls to relieve pressure build up.



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11. Avoid large wall openings near the roof-line as this will weaken the ability of roof to distribute loads to the rest of the structure.

12. Recessed building sections and courtyards may aggravate the effects of high winds. Consult an engineer if possible.

Fig. 2.59 continued

Some recommendations in the nature of guide[1] lines to private builders are given in the Antidisaster Plan of the Tamilnadu Govt. These were explained in a series of drawings which are reproduced in Figs. 2.59-2.62. Evidently these recommendations together with those of ARTIC are influenced mainly by requirement of keeping the costs of the houses low. But it is not known upto what wind velocities these houses would stand up and further there are no recommendations at all for making the houses proof against storm surges. It is therefore necessary that Indian standards Institution should lay down a cyclone code for construction of low cost housings for the weaker sections of the community.

2.375 PROTECTION AGAINST STORM SURGES :

For permanent protection against storm surges the methods for protection of sea coasts against erosions by sea waves using concrete as the basic material for this is the natural substance to use for rebuilding and rehabilitating the water holding structures. The initial costs tend to be high and only selected areas in the CPARs can be so protected if the budget provisions can be made in the CPPC for the State. The most effective artifices are tetrapods and dolosse. The tetrapod has the shape of a caltrop consisting of a central body out of which four legs radiate out maintaining 120° between each other. The dolosse has the shape of the letter H with one leg turned 90° with respect to the other. The shape and interlocking configuration of these units provide for a higher stability factor and reduced the wave run up velocities than imported rocks which are more expensive. Further the larger openings between these units prevent hydrostatic back pressure. Normally each of these units weigh 6 tons. More expensive are the sea walls which may need precast interlocking concrete panels placed under the reinforced earth system. In an emergency when nothing much is available the energy of the storm surge may be dissipated to some extent by employing throw-away motor tyres/chained cannister cans. Experiments should be carried to see how the houses built on platforms fixed to high stilts lifting them above the usual height of storm surges stand up to their fury. Free flow of water below the platforms around the stilts should reduce the devastation potential of the storm surges. In this area also the Indian Standards Institution may study the storm surge data collected by the IMD over the years and also the data of the damages to dwellings in CPARs caused by these surges and evolve a storm surge code for such dwellings. There is evidently much scope for R&D for the Research Institutes, in particular the Building Research Institute of the CSIR. If some promising design is evolved, the State Governments in the CPARs may try out the designed systems in selected areas and select the best economic design for its poorer section of the population.

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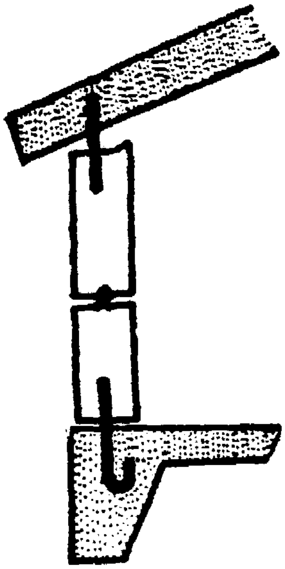
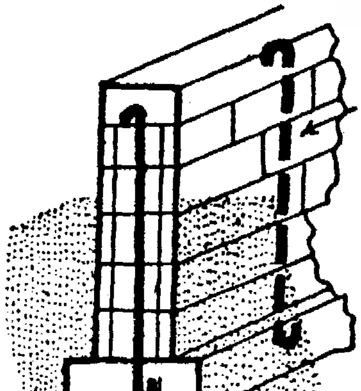
* 1. Anti Disaster Plan State of Tamilnadu : Government of Tamilnadu (1978).

Construction



13. Make sure that all elements of the house are securely tied together, from foundation to roof.



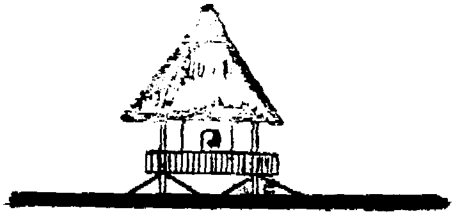
14. Place masonry blocks on a continuous concrete footing in a trench. Avoid placing masonry blocks directly on the ground, as this will make your building settle unevenly, causing wall cracks and openings for wind to penetrate. In extreme cases uneven settlement may bring about building collapse.

15. Whatever the structural materials, be sure to anchor them solidly to the foundation, using dowels, reinforcing bars, tie-rods or other connectors suited to the material. Embed anchors at least 25 cm into the footing.

16. Anchor masonry walls and piers to the foundation with 15 mm rods spaced (in case of wall) not more than 2m apart.

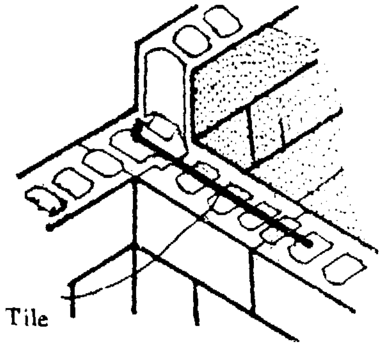
Fig.2.60 : Guide lines by Tamilnadu Government to builders of cyclone proof houses : mode of construction. Reference 102.

17. If a floor is raised off the ground and supported on posts, piers, or pilings, anchor the corners to the ground using galvanized steel anchor pipe.



18. Tie corner columns or posts securely to adjacent walls using tiebars and/or horizontal reinforcement.

19. Make intersecting walls continuous by means of tiebars and/or horizontal reinforcement that extends into neighboring walls and partitions.

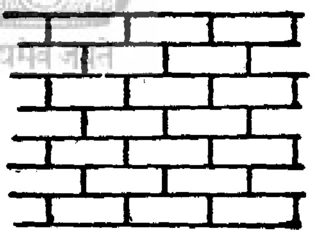


20 Keep wall openings small at corners so as not to weaken the structure.

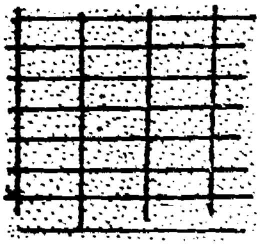
21. Protect glass with louvers or other means to avoid breakage by flying debris.

22. When using in hill wall construction, be sure to tie vertical and horizontal reinforcement securely into the adjacent structure and foundation. Use 8 mm bars with end books.

23. Use running rather than stacked bond when building with masonry.



Running bond



Stacked bond

24. To control cracking, reinforce brick, concrete block, adobe or other masonry block construction internally using metal rods, split cane, bamboo or other ties embedded in grout. Be sure to maintain a tight bond between the reinforcement and the surrounding material.

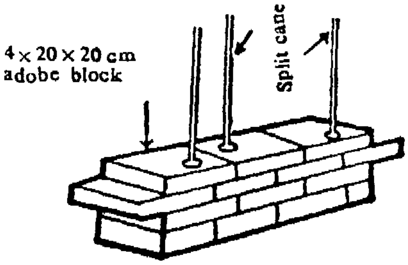
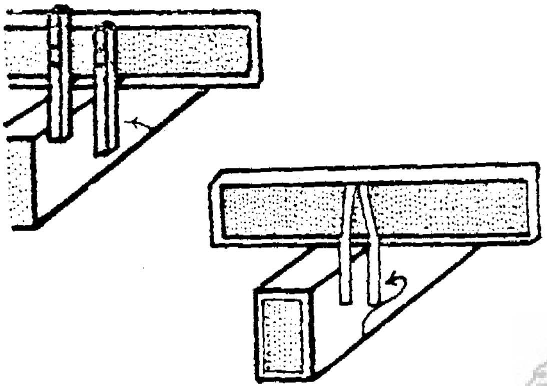


Fig.2.60 : continued

25. Ensure positive connections between door and window sills, posts and lintels and the walls in which they are placed.

26. Near the ocean or other corrosive atmospheres, protect metal reinforcing bars, ties and other connectors from corrosion by covering over with a waterproof material.

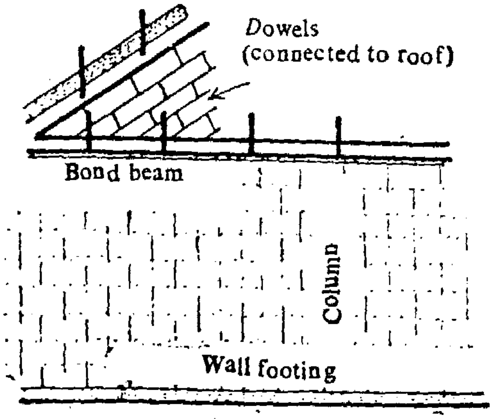


27. To resist twisting of timber joints, use connectors in pairs, one on either side of the members being joined or tie with a metal strap.

28. Avoid flexible joints as they are subject to large displacements under lateral or uplift loads.

29. Avoid using mortar alone to fill small uneven wall openings. It is better to cut masonry units to fit these openings.

30. Insist on high quality masonry. For example, adobe may be made to better resist abrasion, heat and water by stabilizing it with rapid curing road-oil or an asphalt emulsion.



31. When building with masonry, use bond beams to connect all load bearing elements.

Fig.2.60 : continued

Roof

32. Be sure to tie the roof securely to its supporting walls or posts ignoring this caution is the single greates cause of destruction due to high winds.

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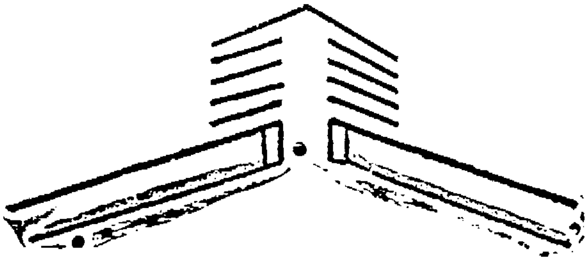
33. Consider ventilation slots placed at the ridge. These are very effective in reducing the internal pressure and thus decreasing total uplift on the roof.



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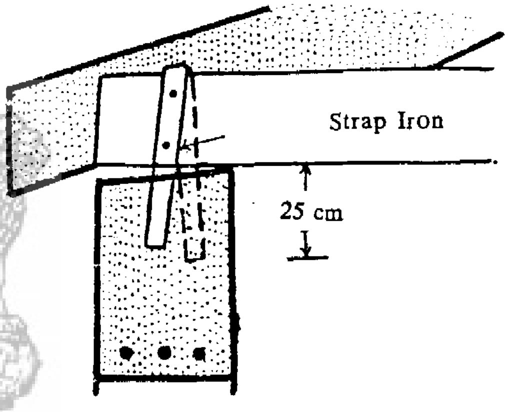
34. When connecting a timber roof to a masonry wall, extend the fastener strap over and arround the roof joist. Nail it to the joist and embed the ends in the concrete or mansonry to depth of 25 cm.



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35. Tie roof-framing to timber walls with sheet metal straps or brackets or wood cleats. Nail straps to members, being sure to drive nails laterally, not in direct pull.

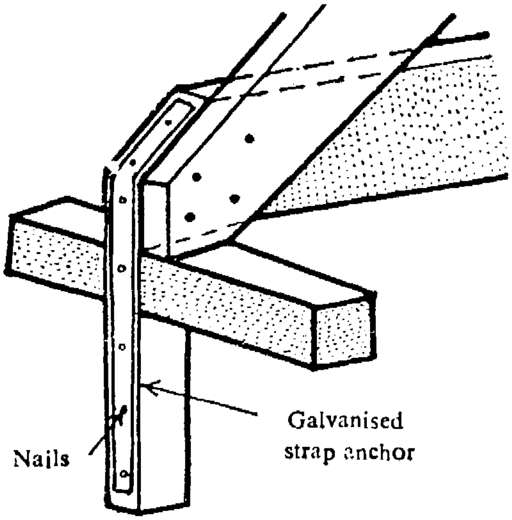
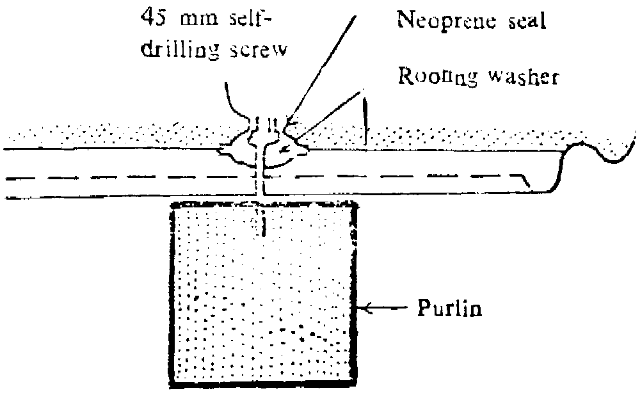
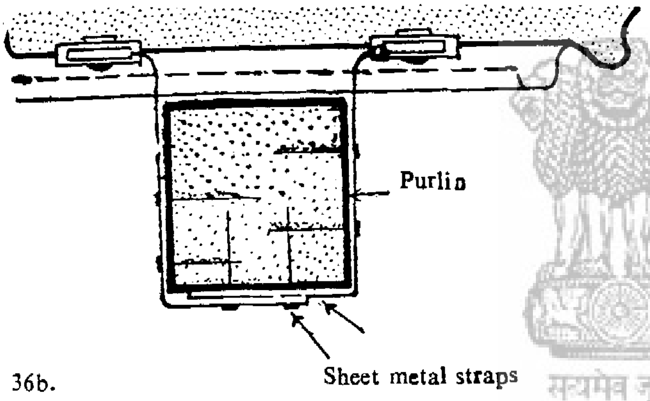


Fig.2.61 : Guide lines by Tamilnadu Government to builders of cyclone proof houses : construction of roof. Reference 102

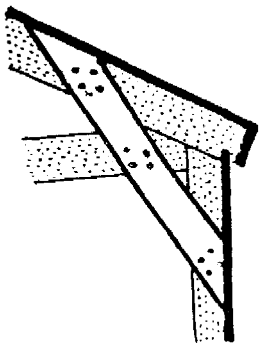


36a.

36. When using screws to attach a corrugated iron roof to wood purlins, use self-drilling screws if possible, spaced no more than three corrugations apart, with a screw head or washer of at least 20 mm in diameter. For regions of intense uplift pressure, the screws should be placed no more than two corrugations apart. If sheet metal straps and rivets are used, wrap the straps completely around the purlins.



36b.



37. For extra bracing against racking and uplift of wood frame wall and roof, consider a continuous diagonal timber brace nailed to wall studs, joist and rafter.

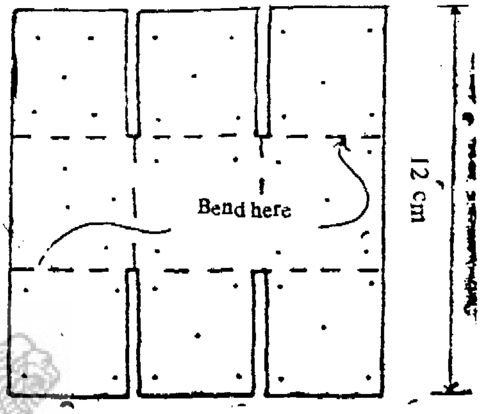
38. Choose and attach the roof cladding with great care. Cladding dislodged by wind can set off a chain reaction that will quickly destroy the roof's stabilizing function. Protect perishable cladding such as thatch, and replace damaged portions.

Fig.2.61 : continued

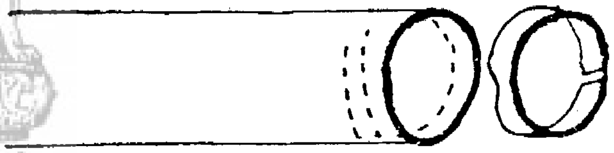
Hints for Local Fabrication

39. Sheet metal straps may be easily fabricated with few tools. Use a minimum thickness (20-gauge) galvanized sheet metal. A width of 30 mm and a length of .5m suits many applications.

40. A multipurpose bracket can be fabricated from 20-gauge galvanized steel sheet. Dimensions can vary. Slits cut in the sheet metal permit forming the bracket for a variety of uses.



41. Split-ring connectors for roof trusses may be fabricated by cutting 20 mm wide sections from 75 mm diameter steel pipe, and then cutting the ring at an angle.



42. Metal plate connectors for truss joints may be fabricated locally, usually from 20-gauge galvanized sheet metal. The sheet metal is punched in a way that produces barbs or teeth at right angles to the plate.

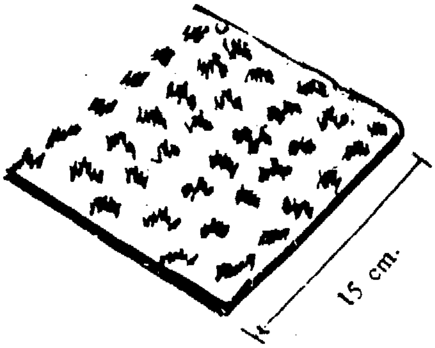
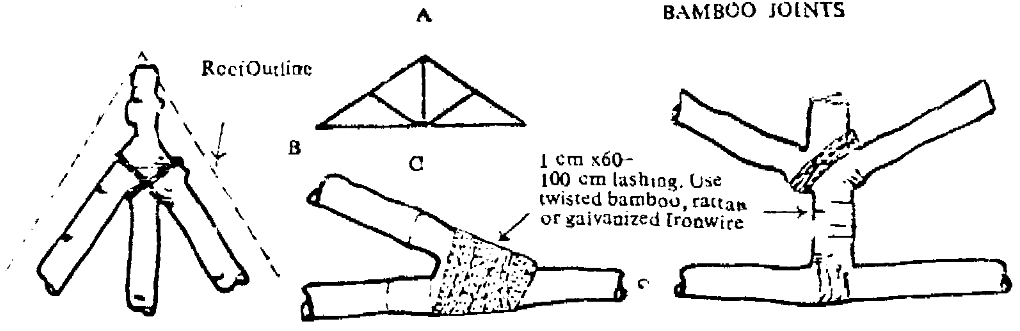


Fig.2.62 : Guide lines by Tamilnadu Government to builders of cyclone proof houses : hints for local fabrication. Reference 102

43. These additional connection details may be used with variations as needed for the requirements of each case.

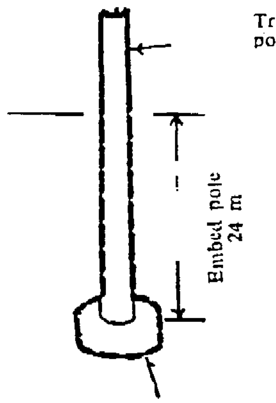
BAMBOO JOINTS



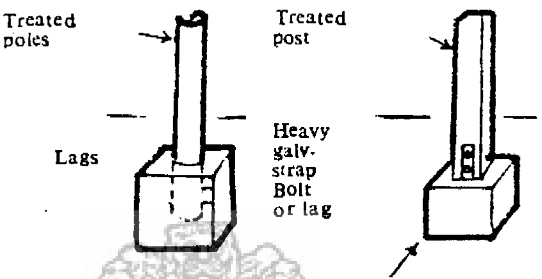
DETAIL A DETAIL B DETAIL C

Bamboo details drawn from the free publication "The Use of Bamboo and Reeds in Building Construction." Department of Economic and Social Affairs. United Nations. New York, NY. Catalogue No. ST/SOA/113.

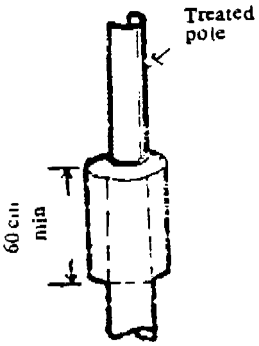
EMBEDDED POLE



Timber or concrete pad

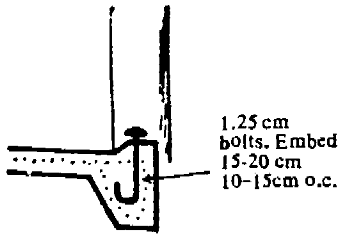


POLE POST
WITH CONCRETE FOOTINGS

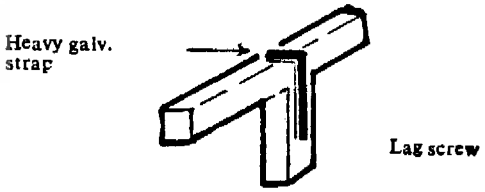


CONCRETE COLLAR PERMITS
SHALLOWER EMBEDMENT

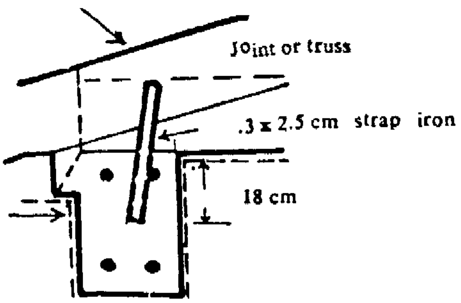
WALL-TO-GROUND SALE

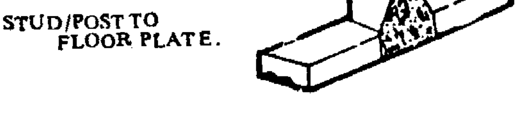


SECURE BEAM TO POST



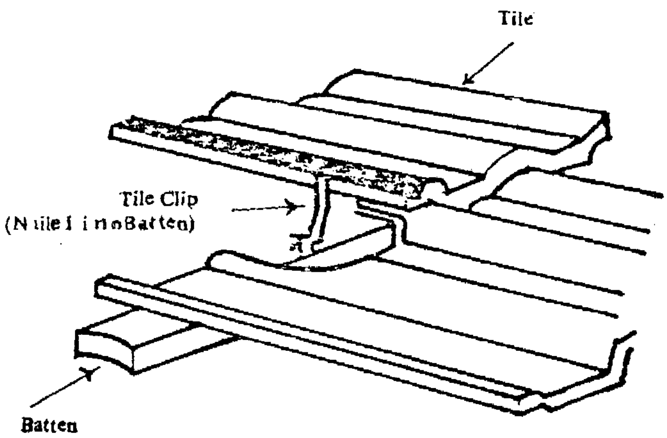
TIMBER TO CONC. BEAM



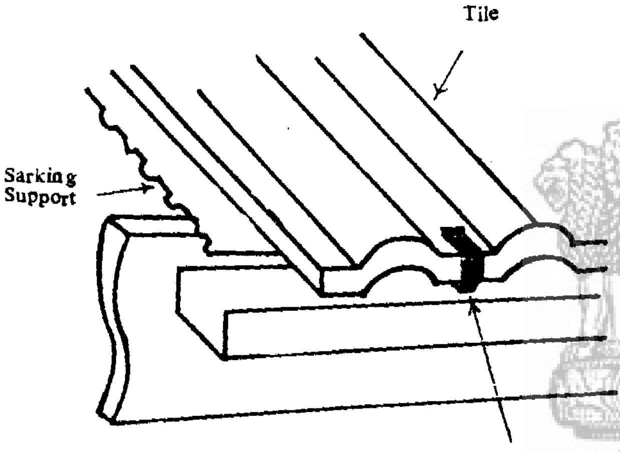


STUD/POST TO
FLOOR PLATE.

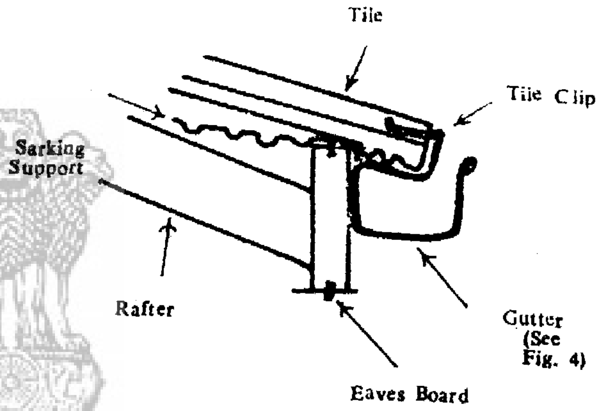
Fig.2.62 : continued



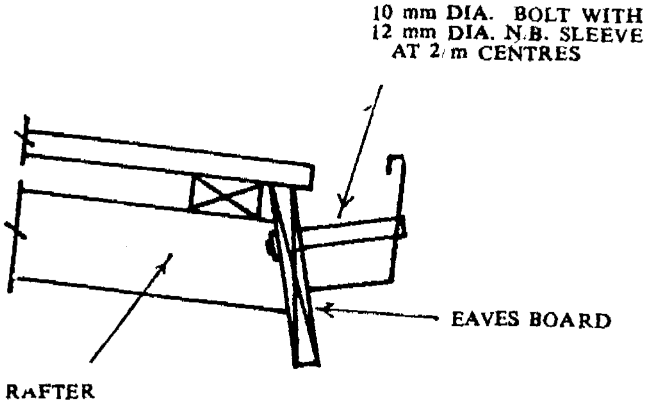
Typical example of tile fixing



Typical example of eaves

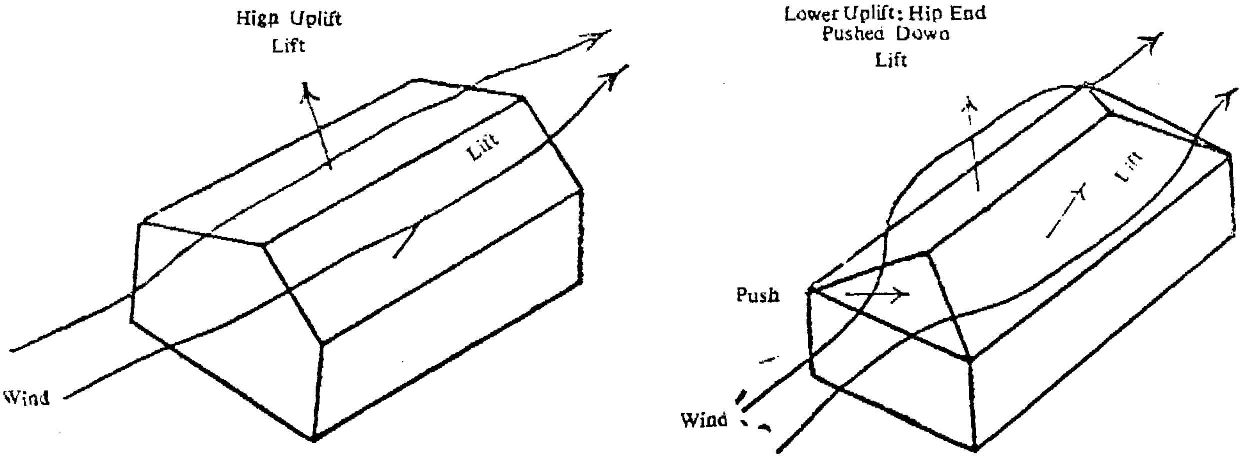


(*Note* : It is suggested that a positive fixing, e.g. a screw, through the tile clip into the eaves board may be necessary. Also that this detail allows rotation at eaves board.)



POSITIVE FIXING OF GUTTER TO STRUCTURE

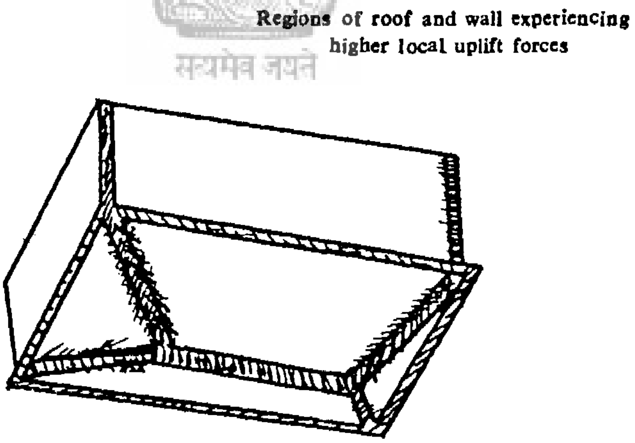
Fig.2.62 : continued



Steep Cable-ended Roof
(Not Recommended)

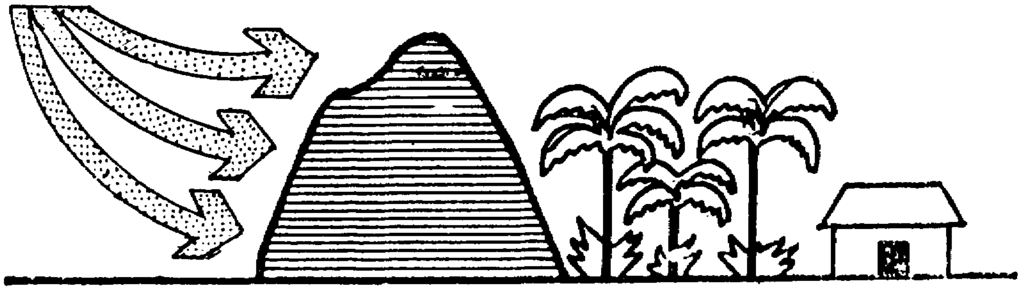
Steep Hip Roof
(Recommended)

EFFECT OF HORIZONTAL WIND FLOW ACROSS A ROOF

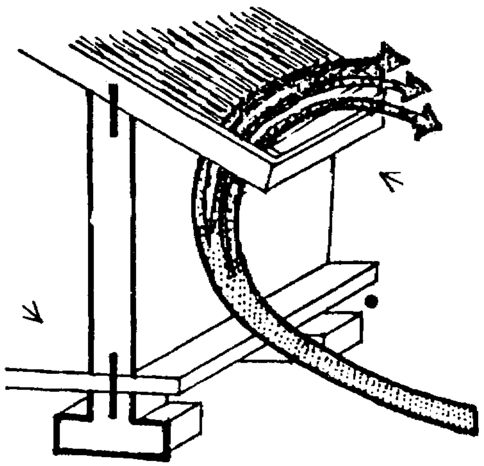

Regions of roof and wall experiencing higher local uplift forces

REGIONS OF ROOF EXPERIENCING HIGHER LOCAL UPLIFT FORCES
(HENCE REINFORCING BAND TO BE PROVIDED)

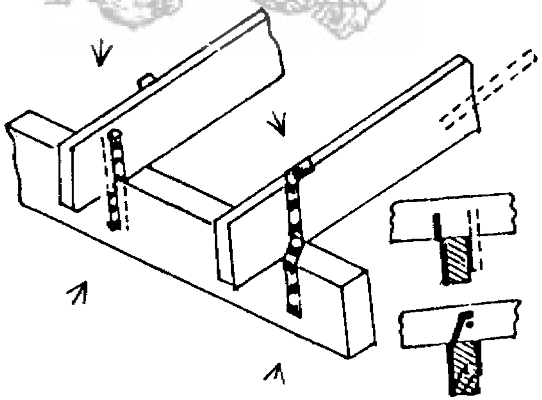
Fig.2.62 : continued



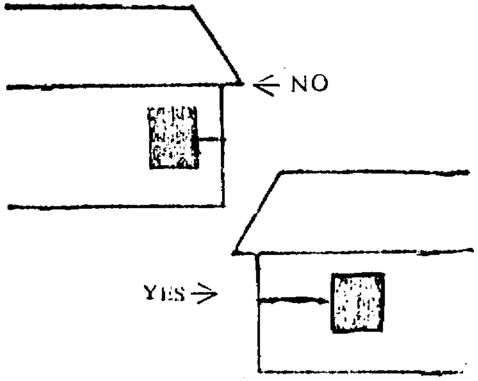
Place your house so it is sheltered by a hill or trees.



Firmly connect all parts of your building from roof to ground. Keep any overhang small or allow wind to blow through it.



Fasten your roof joists to *both* sides of the rafters to prevent twisting.



Do not place windows or openings in your house near the corner.

Fig.2.62 : continued

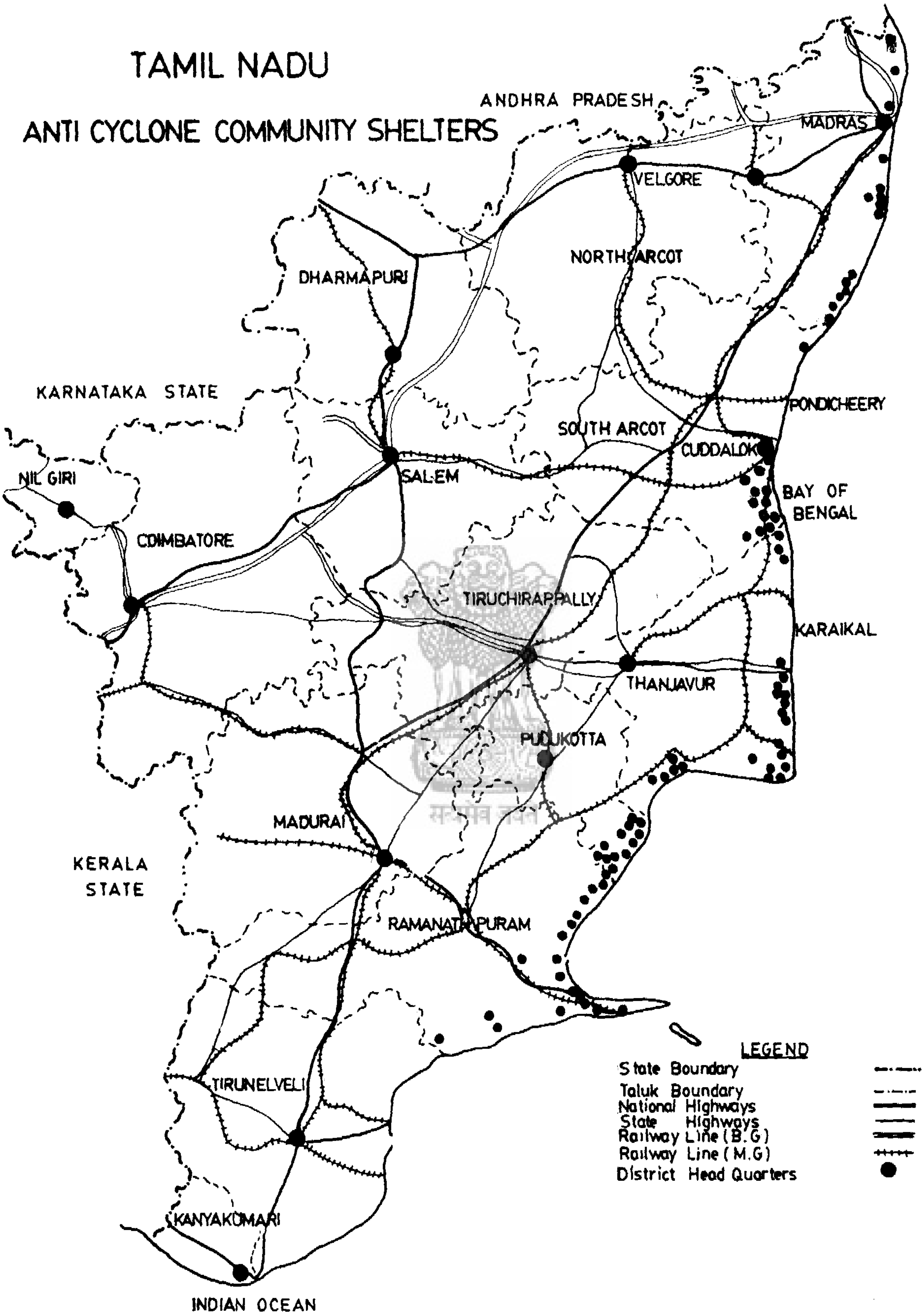


Fig.2.63 Location of cyclone shelters (CYSHELs) in Tamilnadu by courtesy of Dr. N. S. Bhaskara Rao of IMD

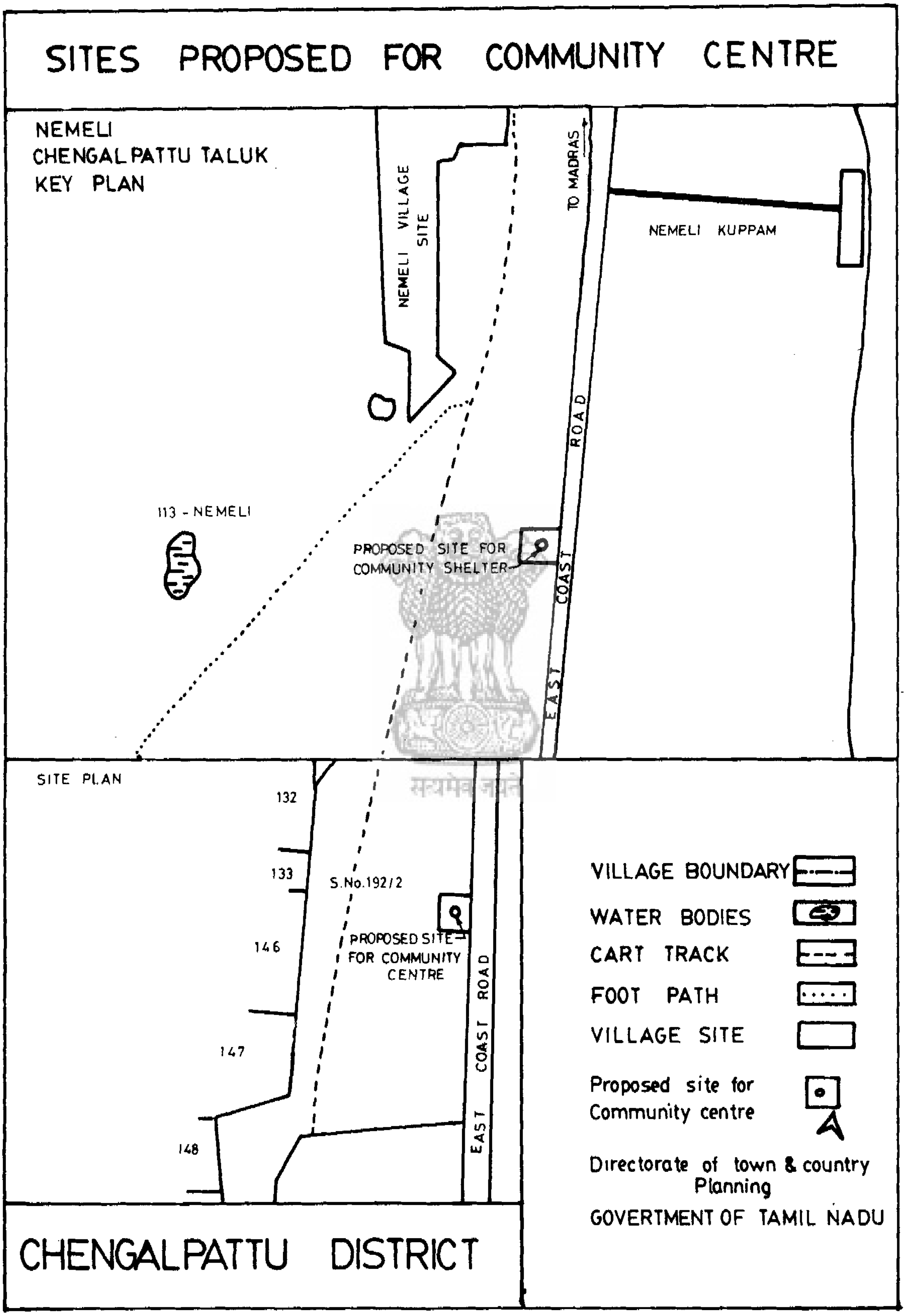


Fig.2.64 The neighbourhood of a typical CYSHEL in Tamilnadu.
By courtesy of Dr.N.S.Bhaskara Rao of IMD

Legend to Fig.2.64

Information : The village is situated on Madras-Masulipatnam east coast road at 50 km from Madras and the village site is 2 km from the Bay of Bengal. In survey No.191/2 it is shown as a perambooke land of 54 acres, comprising mainly of grazing fields. A school is selected for construction of building for cyclone and flood affected people. The proposed site has access with Madras-Mamallapuram road and it is the only part of the perambooke land elevated in the site. The school is located behind the site in a low lying area.

Hamlets : 1.Perur, 2. Nemmali Kuppam, 3. Kutti Kuppam,
4. Kalpakkam, 5. Sulerikkadu

Population : 1693 as per 1971 census

Road facilities : 1. Main road Madras-Mamallapuram road
2. Cart tracks and foot paths are the other roads available in the village
Except the main road, all others are in very bad condition

Number of houses : 360

Classification of houses : Mud wall with thatched or other type roofs

Water supply : Well water for drinking

Educational facilities : One primary school

Medical relief : Available at Kalampakkam village

Street lights : Only few lights are available

Appendix 2.18 : Cyclone Shelters

2.376 LOCATION OF CYCLONE SHELTERS IN THE COASTAL STATES :

Detailed information was obtained about the location of the CYSHELs in Tamilnadu and this has been shown in table 2.78 and fig. 2.63[2].

TABLE 2.78

Location of the sites of CYSHELs in Tamilnadu

District	Taluk	Location of CYSHEL
1. Chengalpattu	1. Chengalpattu	1.Kelambakkam
		2.Kovalam
		3.Muttukadu
		4.Nemili
		5.Saluvankuppam
	2. Madurantakam	1.Kadalorekuppam
		2.Kottaikadu
		3.Mudaliyarkuppam
		4.Paramankeni
		5.Vadapattinam
		6.Vembanur
	3. Ponneri	1.Kattupalli
		2.Karimanal
	4. Saidapet	1.Injambakkam
		2.Thiruvottiyur
	Total :	15
2. Ramanathapuram	1. Mudukulathur	1.Kannirajapuram
		2.Mariyur
		3.Periyakulam
	2. Paremakudi	1.Pandiyur
	3. Ramanathapuram	1.Alagankulam
		2.Athangarai
		3.Chttarikottai
		4.Devipattinam
		5.Mandapam
		6.Nagachi
		7.Pudumadam
		8.Uchipuli
	4. Tiruvadanai	1.Marunkur
		2.Pudupattinam
		3.Tirupalakudi
		4.Tondi
		5.Uppur
		6.Vattnam
	Total :	18

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* 2 Information given by Dr.N.S.Bhaskara Rao of IMD.

District	Taluk	Location of CYSHEL
3. South Arcot	1. Chidambaram	1.Jayankondapattinam
		2.Kanakkarpattu
		3.Kilkundalapadi
		4.Killai
		5.Kilperambai
		6.Kilthinkkalipalli
		7.Pichavaram
		8.Thandavarayacholagampatti
		9.Vallampadugai
	2. Cuddalore	1.Alapakkam
		2.Andarmullipallam
		3.Kalaiyankuppam (Periyakuppam)
	3. Tindivanam	1.Koonimedu
	Total :	13
4. Thanjavur	1. Mayuram	1.Kalamanallur
	2. Nagapattinam	1.Akkaridpettai
		2.Nambianagar
		3.North Poyyur
		4.Pradabaramapuram
		5.Tiruppondi (East)
		6.Vettaikkaraniruppu
		7.Vilundamavadi
	3. Pettukkottai	1.Anthonipuram
		2.Eripurakkarai
		3.Kallivoyal
		4.Rajamadam
		5.Sethubavachatram
	4. Sirakali	1.Pudupattinam
		2.Tirumullaivasal
		3.Vettangudi
	5. Tirutturaipoondi	1.Kodiyakadu
		2.Koilpattu
		3.Panchanadhikulam
		4.Pannal
		5.Pushpavanam
		6.Vedaranyam
		7.Vellapallam
	Total ..	23

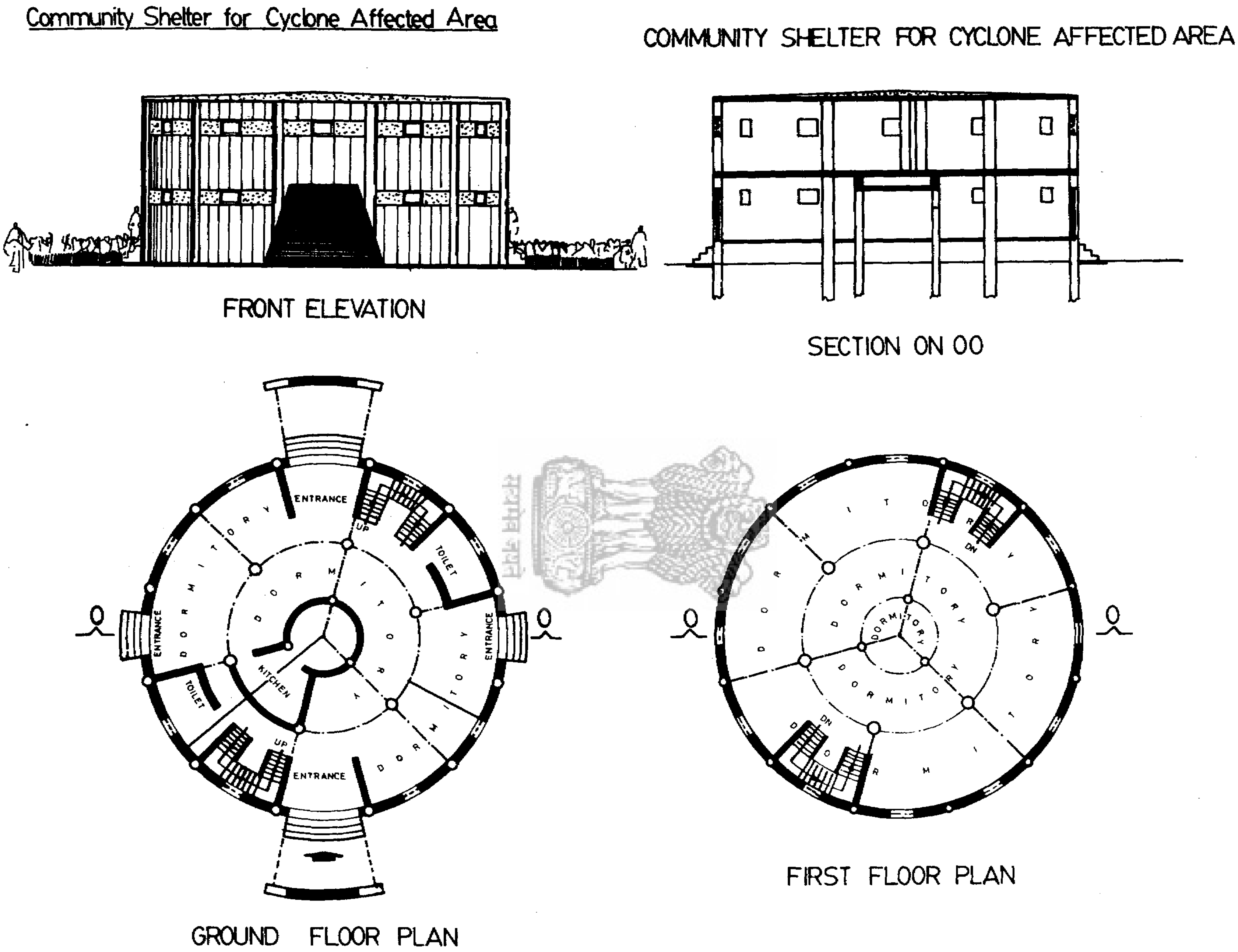


Fig.2.67 Plan of a typical circular community centre/CYSHEL in cyclone prone area of Tamilnadu. By courtesy of Dr.N.S.Bhaskara Rao of IMD

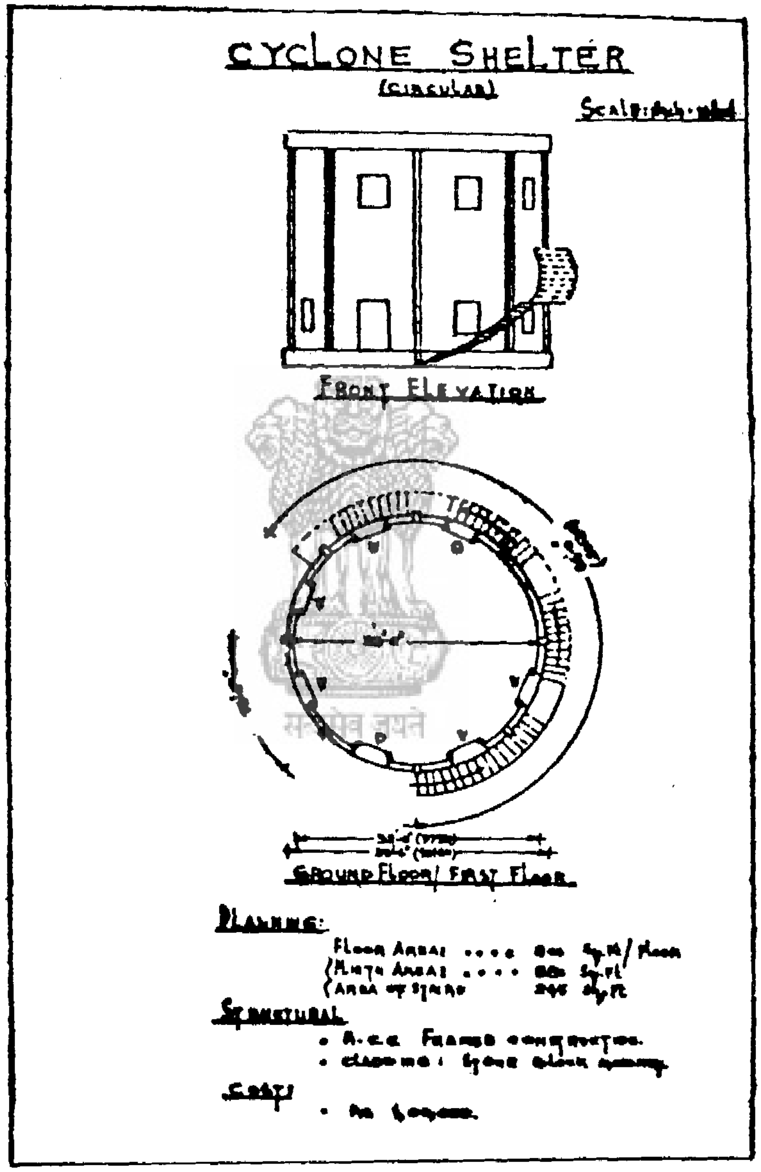


Fig.2.66 Plan of a typical circular CYSHEL in Andhra Pradesh. Reference 87

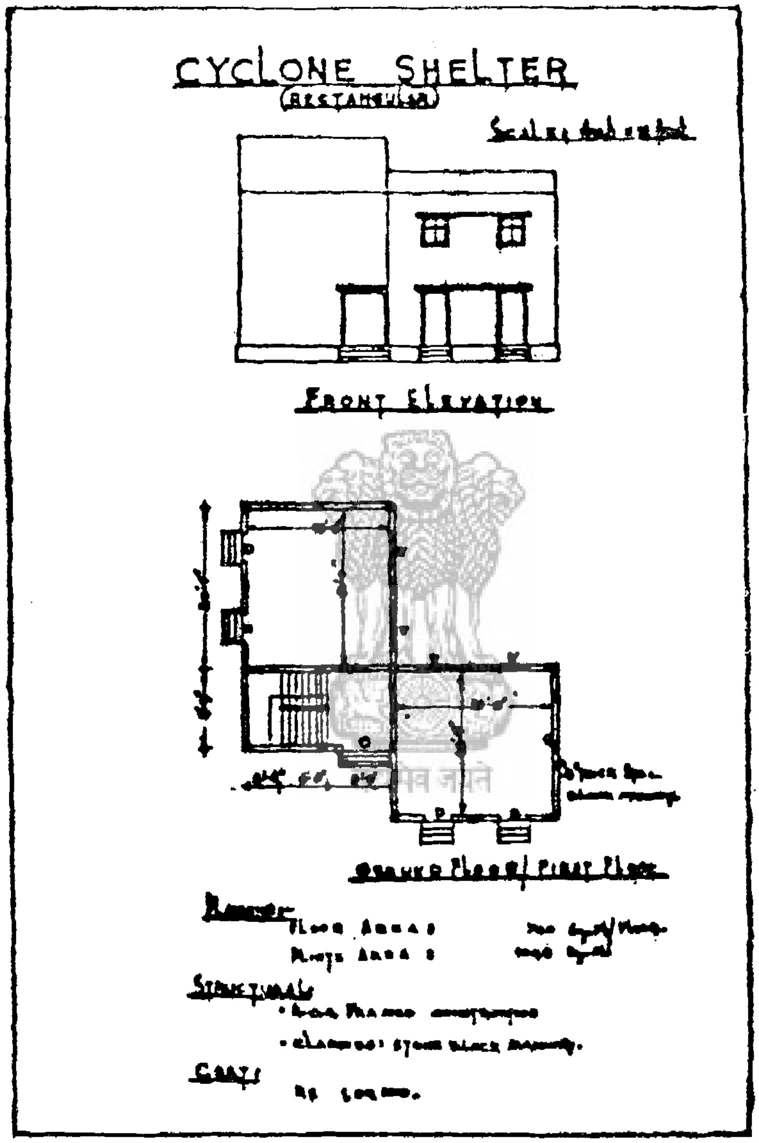


Fig.2.72 Plan of a typical rectangular CYSHEL in Andhra Pradesh. Reference 87

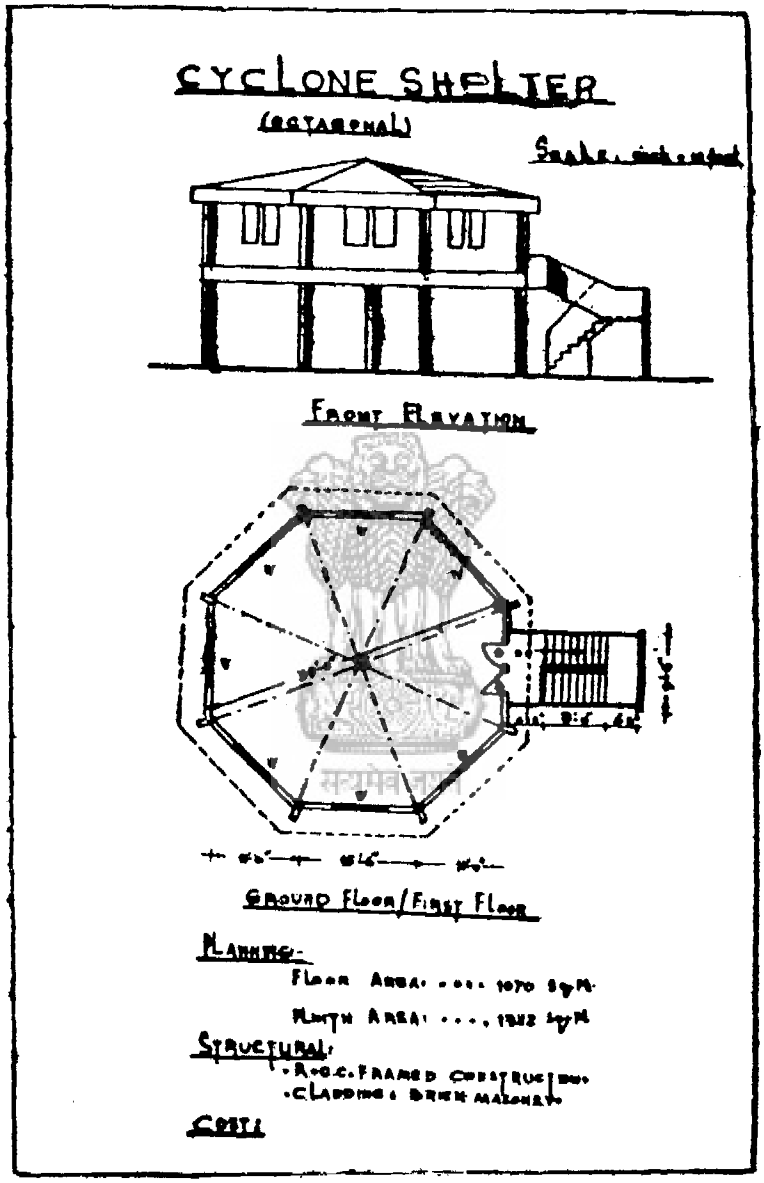
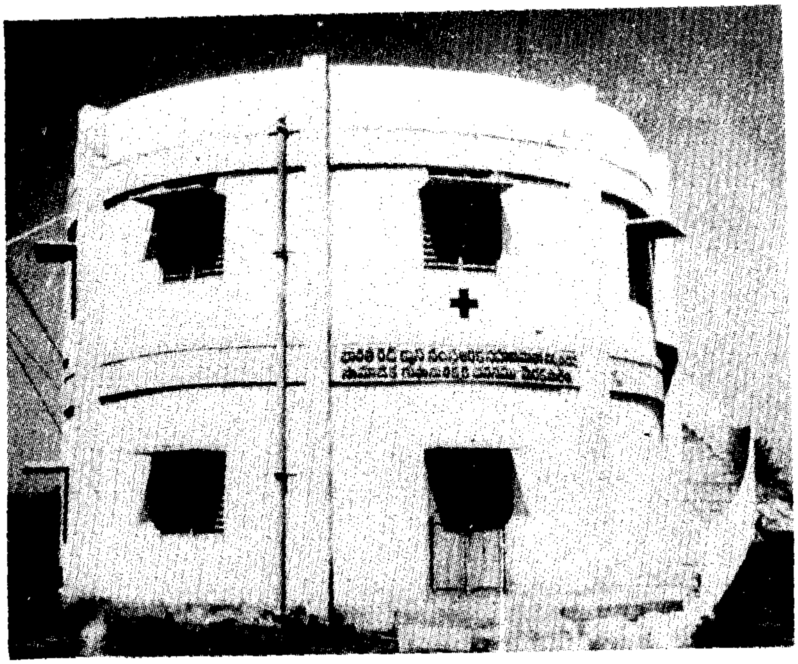
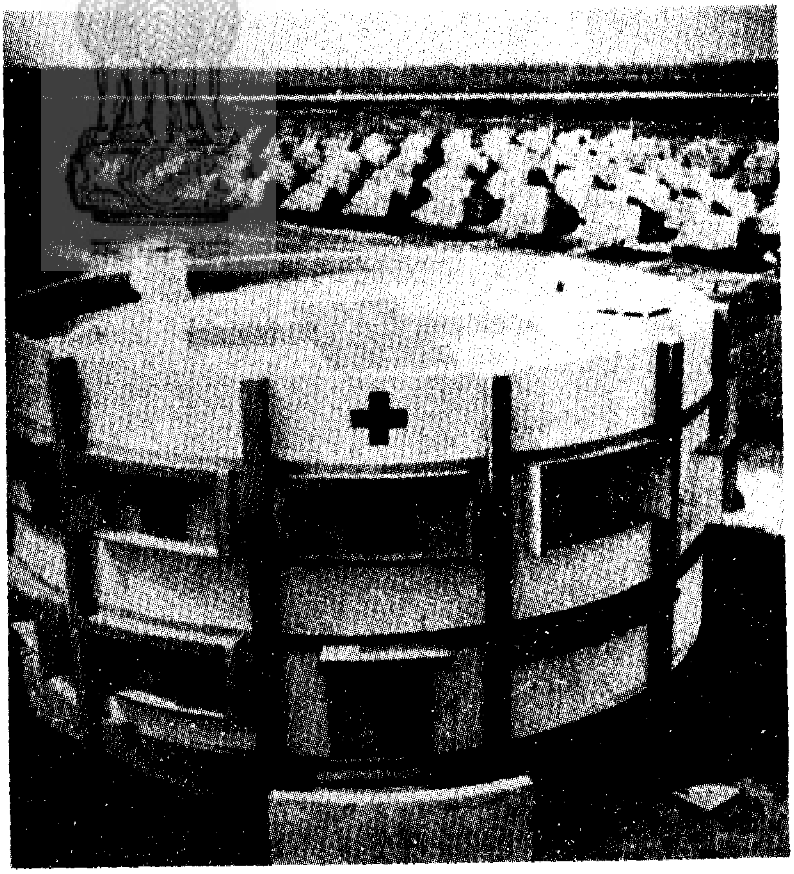

CYCLONE SHELTER
(OCTAGONAL)
Scale:
FRONT ELEVATION
GROUND FLOOR/FIRST FLOOR
PLANNING:-
FLOOR AREA: .... 1070 Sq.M.
PLINTH AREA: ...., 1242 Sq.M
STRUCTURAL:
·R.C.C. FRAMED CONSTRUCTION.
·CLADDING: BRICK MASONRY.
COST:

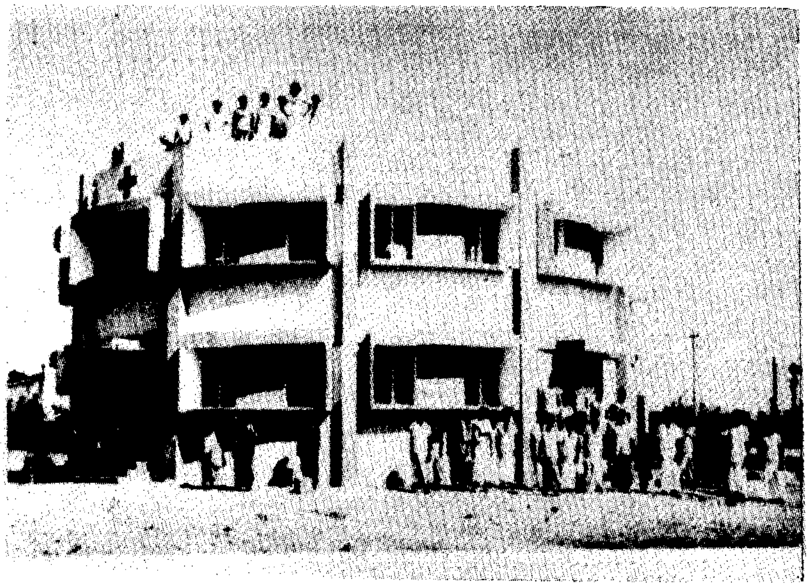
Fig.2.70 Plan of a typical octagonal CYSHEL in Andhra Pradesh. Reference 87



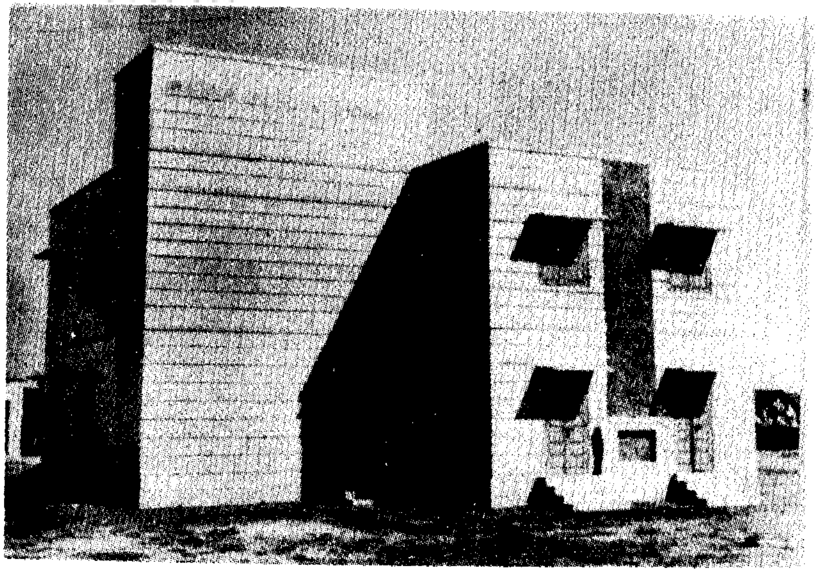
A typical circular Cyclone Shelter (CYSHEL) in Andhra Pradesh. Photograph provided bv Prof. R. Ramanadham, member of CRC.



A typical circular CYSHEL in Tamilnadu. Photograph obtained by courtesy of Dr. N. S. Bhaskara Rao of the IMD.



A typical circular CYSHEL in Tamilnadu. Photograph obtained by courtesy of Dr. N. S. Bhaskara Rao of the IMD.



A typical rectangular CYSHEL in Andhra Pradesh. Photograph provided by Prof. R. Ramanadham, member of CRC.

District	Taluk	Location of CYSHEL
5. Pudukottai	1. Arantangai	1.Kattumavadi
		2.Kottaipattinam
		3.Krishnajipattinam
		4.Manamelkudi
		5.Manamelkudi (Avadaiyapattinam)
		6.Melesthanam
		7.Mimisal
		8.Munsbalai
		9.Muthukida
		10.Nattanipurasakudi (Gopalapattinam hamlet)
		11.Nattanipurasakudi (Pudupattinam hamlet)
		12.Palanakulam
		13.Periyamadaipaichel
	Total ..	13

For Andhra Pradesh[1] has a long coast line. The districtwise coast line length is shown in table 2.79.

TABLE 2.79

Length of districtwise coast line of Andhra Pradesh

District	Length of coast line(km)
1. Godavari (East)	177
2. Godavari (West)	17
3. Guntur	62
4. Krishna	122
5. Nellore	174
6. Prakasam	116
7. Srikakulam	207
8. Visakhapatnam	155
	1030

The final selection of villages/hamlets/habitation selected for construction of CYSHELs in Andhra Pradesh is shown districtwise in table 2.80.

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* 1 Community Cyclone Shelter Construction Programme for Cyclone prone coastal areas of Andhra Pradesh Government of Andhra Pradesh Revenue Department (1980).

TABLE 2.80

Total proposal for sites for CYSHELs in Andhra Pradesh

District	Number of villages/hamlets/habitation selected as site of CYSHEL Distance from sea (km) ≤5	5-10	10-20	Total
1. Godavari (East)	77	76	89	242
2. Godavari (West)	20	28	7	55
3. Guntur	53	15	26	94
4. Krishna	40	49	47	136
5. Nellore	86	61	80	227
6. Prakasam	19	25	79	123
7. Srikakulam	88	53	43	184
8. Visakhapatnam	105	75	95	275
	488	382	466	1336

The actual names of the villages/hamlets/habitation selected for construction of CYSHELs will be found in the publication by the Revenue Department of the Government of Andhra Pradesh : Community Cyclone Shelter Construction Programme for Cyclone Prone Coastal Areas of Andhra Pradesh (1980).

2.377 A TYPICAL CYSHEL AND ITS ENVIRONMENT :

A feeling for the choice of location of a CYSHEL can be obtained from a study of the environment of a typical shelter. The Nemali village is situated on the Madras east coast road at 50 km from Madras city. The village site is 2 km from the Bay of Bengal. Survey No.191/2 shows a porambake land of 54 acres consisting mainly of grazing fields. A school is selected for construction of the building for Cyclone/flood shelter. The proposed site has access to the Madras-Mumallapuram road and it is the only part of the porambake land well elevated in the area. The school is situated behind the site in a low lying area. The following hamlets will be served by the proposed CYSHEL : Kalapakkam, Kattukupam, Nemmali Kuppam, Sulerikkadu and Perur. The total population is 1693 as per 1971 census. The road facilities are : 1) Main road Madras-Mamallapuram road, 2) Cart tracks and foot paths are the roads available in the village. Except the main road the other roads are in very bad state. The number of houses is 360 and the houses have mud walls with thatched or other types of roofs. Well water is available for drinking purposes. The primary school is available. For medical relief people go to Kelambakkam village. Only few street lights exist. Figure 2.64 shows the proposed site of the CYSHEL.

2.378 SOME DESIGNS OF CYSHELs

In paragraph 2.302 it has been pointed out that the CYSHELs have been constructed with circular, octagonal or square/rectangular shapes. Some typical plans for these various shapes are shown in figures 2.68 and 2.72. The arrangements of the various rooms housing the different facilities are shown in these figures.

Appendix 2.19 : Cyclone Stores

2.379 EPIDEMIC CONTROL/MEDICAL STORES :

In paragraph 2.306 the need for establishing various types of Cyclone Stores at strategic points in the CPARs has been discussed. The typical materials to be stored in the medical and epidemic control stores will be discussed. The list is by no means complete.

1. Epidemic Control Store (ECSTOR)[1] : These stores should interalia the following items -

a) vaccines : Black quarter vaccines Anticholora vaccine T.A.B. vaccine, Tetanus Toxcid Nanemorhagic Septicaemia, Catero Taxocoenia, Ranikhet vaccines. Jet vaccine machines.

b) Disinfectants : Bleaching powder, liquid chlorine, water purifying tablets, phenyl/creosol, herrock boxes and chloroscopes for testing quantity of free chlorine and supplying of safe protected drinking water.

c) Insecticides : DDT, Purathrum and Bygon salt

d) Drinking water transport vehicles/cans : Mobile water tankers, canvas water tanks, drums and jerry cans

e) Equipment for public latrines : Wooden platforms (10'x4') with holes (12'x10') with lids for construction of deep trench latrines in the Relief/Rehabilitation camps providing 10 seats for 100 persons. Sidewalls/partitions to be built of bamboos, mats, sirkimats, palmyra leaves etc.

2. Medical Stores(MEDSTOR)[1,2]: These should contain interalia the following items :

a) Normal medicines/drugs/antibiotics : To take care of Diarrhoeas, for chemotherpautic needs, antimalaria treatments. Antipiretics, analgestic, antiallergic drugs, chloresol (oral rehydration compound, IV compounds Paediatrics. Formulations for treatments of Gastro-enterites and Respiratory infections in children.

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* 1 Cyclone Contingency Plan of Action : Revenue Department, Government of Andhra Pradesh (1981)

2 Anti Disaster Plan for State of Tamilnadu: Government of Tamilnadu (1978).

b) First aid kit for each worker: water bottle with sling, torch, first aid pouch containing: triangular bandages, canes for tourniquets, shell dressings, First field dressings, safety pins, sharp 7 long scissors, tourniquets, clasp knife, lables, casuality identity cards.

c) Equipments for first aid parties: Metal stretchers blankets, ground sheets for stretchers, hot water bottles, leg splint sets, straps for leg splints. Esmarch's bandage (India rubber), Haversack containing : triangular bandages, cane pieces for tourniquets, Cotton wool, shell dressing, square lings (18'x12'), first field dressing, large safety ins, clasp knife, 7" scissor, tourniquets, wooden sectional splints, straps for sectional splints, Labels, casuality identity cards.

d) Camping equipments: Tarpaulins (12'x12'), tents, pegs/poles/ropes, hammers.

e) Equipments for First Aid posts : Stretchers - Standard and improvised, blankets, ground sheets/water proofs, Rubber hot water bottles, wood/wire/improvised splints, water bottles with cups, bowls for preparing disinfectants, improvised sterilisers, primus stove, hammersacks for carrying bandages/dressings/drugs, miscellaneous items as scissors/dressing forceps/drugs, miscellaneous items as scissors/dressing forceps/tourniquets/torch.

f) Medical stores for first aid posts: Acid acetyl salicylic tablets, sulphadiazene tablets, Lyson, Morphine sulphate 1 cc ampules, Nikhethamide 1.7 cc ampules, liquid adrenaline Hydrochlor, Olium Ricni, Peneciline G.2 ratio Unit, Spl. Ammon Aromat, Sodi Dicarbones, Sera ATS ampoule, Jelly Proflavin, Unguentum Atropinae (1% in ½ oz tubes) Mineralised methylated spirits, Drop bottles, mask, Airway medicines.

Appendix 2.20 : The status of implementation of the recommendations of the various State CDMCs:[1]

2.380 IMPLEMENTATION OF THE RECOMMENDATIONS OF THE STATE CDMCs :

Table 2.81 surveys the status of implementation of the recommendations of the CDMCs of Andhra Pradesh, Orissa and West Bengal.

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* [1] Working paper No.24 placed before the Committee by IMD.

TABLE 2.81

Implementation of the recommendations of various CDMCs

State	Recommendation Number as given in the State CDMC report	Status of Implementation
I Andhra Pradesh	3. Police W/T in Andhra State should extend their cooperation in this scheme by taking wind observations and radioing them to the Storm Warning Centre from suitable locations along the Andhra coast wherever they are operating. In addition, in the cyclone situation, on being requested by the Storm Warning Centre, they should also arrange taking and transmitting these observations from non-scheduled places by diverting mobile W/T vans there as is being done in Tamil Nadu.	Police W/T in Andhra State expressed their inability to undertake the task.
	11. The India Meterological Department should establish a storm warning centre at Visakhapatnam for issuing cyclone warnings to the Andhra Coastal Districts.	Implemented
	12. The India Meteorological Department in collaboration with Posts and Telegraphs Department should work out suitable arrangements for the expeditious dissemination of meteorological observaations on telegraphic channels with minimum transit delays.	Arrangements exist for collection of observations by departmental wireless channels from the observatories at Nellore, Kakinada & Visakhapatnam There is a proposal to extend these arrangements at Ongole, Masulipatnam & Kalingapatnam.
	13. The first stage warnings to the Collectors of coastal districts and designated railways officials should be sent by landline telegrams and subsequent cyclone bulletins for these authorities should be broadcast over the AIR Stations. The concerned Collectors, Railway and other authorities should make arrangements for monitoring of these bulletins by officials specially designated for the purpose. In the case of districts which are no longer affected by the cyclone, dewarning messages should be sent by landline telegrams.	Arrangements for dissemination of warnings made from IMD side. As regards uninterrupted reception of these messages by Collectors of coastal districts AIR stations, Railways and other authorities there was no feed-back information.

1	2	3
14.	In cases of failure of usual means of communication alternate arrangements should be made to disseminate cyclone warnings and instructions for distress mitigation through the micro-wave net work of the Railways wherever these facilities exist and the available communication channels of the Civil Aviation Department.. An appropriately high priority should be given by these communicators for the disposal of these messages.	IMD indicated that this recommendation has been implemented but it is not clear whether micro-wave network of railways and communication channels of Civil Aviation Department were at any time used for disseminating cyclone warnings and if so how efficient were these channels.
16.	Cyclone warnings for each cyclone should be serially numbered by the issuing authority and the abbreviated telegraphic address of the sender e.g. Met.Centre, Weather etc. should be invariably given with the warning messages. This will enable the recipients to ensure the authenticity of the message on which they should take action.	Implemented
18.	Telex facilities should be provided at the Storm Warning Centres, Madras and Visakhapatnam the AIR Stations at Vijayawada Hyderabad and Visakhapatnam, the Port Offices at Masulipatnam and Kakinada and Public Works Deptt. (Irrigation) offices at Chirala and Dowlaiswaram for exchange of cyclone warning messages.	Telex facilities are available at Storm Warning Centres at Madras and Visakhapatnam. It is learnt from Director State Ports Administration, Andhra Pradesh that Telex is provided at Port Officer, Kakinada and sanction is accorded for a Telex at Masulipatnam Port Office. Even in 1972, the PWD and Irrigation officials at Chirala and Dowleswaram were advised to have Telex. So far no information has been received from them. In the empowered Committee (ECC)meeting held on 9.8.78 and 29.9.78, under the above recommendation it was decided that Govt. of Andhra Pradesh should take urgent action to place firm demands on P&T for provision of these Telex

		connections. In this regard, Commissioner for Cyclone Relief and Rehabilitation, Ex/Officio Secretary to Government of Andhra Pradesh, Revenue Deptt. was requested to intimate this office of the action taken to provide Telex facilities at these places. AIR Stations at Vijayawada Hyderabad and Visakhapatnam have telex facilities.
19.	On receipt of request from the concerned I.Met.Deptt. Storm Warning Centre, arrangements should be made for round the clock transmission at the appropriate AIR Station, Cyclone bulletin should be broadcast preferably at hourly intervals and sudden unexpected developments as soon as it is notified to the Station.	Implemented
20.	The broadcast of weather bulletins from the All India Radio stations, Vijayawada, Hyderabad and Visakhapatnam should be suitably coordinated so that the same warning bulletin is available to the listeners from any of these stations at close intervals of about 5 to 10 minutes.	Implemented
21.	Due coverage about cyclones approaching the Indian Coast line should be given in the central news bulletins from AIR, New Delhi for the benefit of listeners of All India Bulletins. The Regional News Bulletins should also include them for the concerned regions.	Implemented. However, details of arrangement made by AIR were not available.

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6.	The Posts & Telegraph Department should take urgent steps for the establishment of a coastal radio station at Paradeep Port to facilitate improved reception of ships observations and satisfactory dissemination of weather earnings from these stations. The department should also provide reliable and snap-proof communication links between	Ministry of Transport and Shipping did not agree to set up coastal radio at Paradeep due to proximity of coastal radio at Visakha patnam and Calcutta. Snap proof communication links provided.

	the Paradeep radar on the one hand and the Storm Warning Centre, Bhubaneswar and the All India Radio, Cuttack on the other.	
12.	The India Meteorological Department in collaboration with the Posts & Telegraphs Department should work out efficient arrangements for the expeditious dissemination of meterological observations on telegraphic channels with minimum transit delay. The Posts & Telegraphs Department should upgrade the overhead links with Calcutta and Visakhapatnam to coaxial cable and/or microwave.	Co-axial T.P. links have been provided ? Calcutta, Bhubaneswar, Visakhapatnam for expeditious transmission of weather observation.
13.	The first stage warnings to the Collectors of coastal districts and designated railway officials should be sent by land line telegraphs and subsequent cyclone bulletins for these authorities should be broadcast over the AIR stations. The concerned Collectors, Railway and other authorities should thereafter make arrangements for monitoring of these bulletins by officials specially designated for the purpose. In the case of districts which are no longer affected by the cyclone, dewarning messages may be sent by landline telegrams.	First and second Storm warning are sent direct to Collectors and Railway authorities. Special cyclone bulletins are broadcast through AIR. Arrangements made by the Collectors and the Railway authorities for monitoring the bulletins are not known.
14.	In case of failure of Posts and Telegraphs telecommunications due to cyclone alternate arrangements should be made which should be promptly notified ;by the P&T to the Indian Meteorological Department Storm Warning Centre concerned to disseminate cyclone warnings and instructions for distress mitigation through the microwave network for the Railway and/or AFTN channels of the C.A.D. wherever such facilities exist. For this purpose the Railways and the Civil Aviation Department should arrange for the extension of the watch hours round the clock during the period of cyclone danger. An appropriately high priority should be given by these communicators for the transmission of these messages to their destinations.	Arrangements for transmitting warnings through alternate channels of railway microwave network and AFTN channels of CAD have been made but there is no feed back information about how efficient these two alternate channels are for the purpose.

1	2	3
15.	It was understood that the Railways have plans to install microwave network along the east coast. As this would be valuable aid for speedy transmission of cyclone warning Messages, this may be given a high priority by the Railway Board.	It is understood the work of installing railway microwave network along the coast is under progress
20.	Telex facilities should be provided at the Storm Warning Centres, Calcutta and Bhubaneswar, AIR Station at Cuttack and Bhubaneswar, AIR Station Cuttack and the Port Offices at Paradeep and Gopalpur for speedy transmission of cyclone warning from the concerned storm warning centres.	Telex facilities are provided at ACWC, Calcutta, SWC Bhubaneswar, AIR Cuttack and Port Office Paradeep. Telex facilities at Port Office Gopalpur are yet to be provided.
WEST BENGAL		
7.	The India Meteorological Department should take up with the Bangladesh Meteorological Department the question of the continuous working of the existing landline Teletypo circuit between ACWC Calcutta and the Storm Warning Centre Dhaka and the provision of an alternate Radio teletype channel between the two countries. They may also take up the matters regarding the early establishment of a radiowind station and the cyclone warning Radar at Khenpupara and a pilot balloon observatory at Majidi. The Bangladesh Met.Service may be requested to arrange for speedy transmission to ACWC Calcutta the ships observations received by the coastal Radio station at Chittagong and also Radar observations of Dhaka and Coxs Bazar Radar stations as well as those of Khepupara when commissioned, using the international Radar Code to describe Radar echoes.	Indian Met.Department took up with Bangladesh Meteorological Deptt. the question of continuous working of existing Teleprinter circuit betwe ACWC Calcutta - SWC Dhaka and provision of alternate RTT channel-Bangladesh **is not agreeable at presen** **India has agreed to the Bangladesh suggestion** for a direct T.P. link between N.Delhi - Dhaka in place of Dhaka - Calcutta line. This has apparently been implemented.

1	2	3
8.	In case of breakdown of P&T channel the Inter-State Police W/T or the microwave link of the Railways, when established or the Civil Aviation Deptt. W/T may be used to obtain at Calcutta the wind observations from cooperative stations, and regular observatories from Orissa coast which are collected through Police W/T in a cyclone situation.	Southeast Railway authorities have agreed to transmit on their communication network weather observations, from coastal stations in case of p&T communication failure, and R.C.Calcutta has been requested to furnish the list of stations to the General Manager, Southeast Railway.
13.	In the storm warning bulletin messages issued by ACWC containing surge height forecasts, the values of the normal tide heights should also be specified.	Implemented
14.	In respect of the two stage warning system in force for depressions and cyclonic storms, the first stage warning may continue to be sent by landline telegram to the concerned authorities, whereas the second stage warning and subsequent warnings will be broadcast through AIR. Round the clock monitoring of these broadcasts by the concerned officials mentioned in subsequent recommendations should be arranged.	Two stage warnings are being issued.
16.	Storm Warning messages should be sent from ACWC, Calcutta, to AIR, Calcutta, by Telex. Due to peculiar contour pattern of Sunderbans coast which comprises of a large number of small islands, the main communication system in Sunderbans area is Police WT/RT.	Implemented. But as regards utilisation of communication channels of Police WT/RT there is no information.

Appendix 2.21 : Cyclone education at school level

2.381 PROGRAMME OF EDUCATION ON CYCLONES AT SCHOOL LEVEL IN BURMA[1] :

The Burmese Government has introduced a course on cyclones in the school programmes in that country. The programme is reported to have been very successful and as a result of this programme the loss of life caused by cyclones in Burma has been greatly minimised. As a part of public education many chapters have been included about weather. aberration etc. in the text books and special lectures are also organised in schools and colleges. The following chapters are included in the text books which are in use since 1976 in all schools of Burma and the number of such books circulated is about 10 million each year.

1. Chapter on our Universe	(General Science Text)
3rd. Standard Text	Earth, Sun and Moon; Day and Night, Stars and Planets.
4th Standard Text	Solar System, Stars and constellations and its use in navigation; Solar and lunar eclipse.
5th Standard	Structure of the Atmosphere, Composition of the Atmosphere, change of pressure with height, Change of temperature with height.
6th Standard	Moisture in the atmosphere, Formation of rain and clouds. Change of air Mass. Change of temperature due to meteorological conditions.
7th Standard	1. Formation of storms 2. Bay of Bengal Cyclones 3. Damage due to Cyclones 4. Precaution against cyclone 5. Prevention of Cyclones.
8th Standard	1. Weather Forecasting 2. Weather Information and Exchange of Data 3. Observations 4. Forecasting
2. Chapter on Air around us	(Same Text)
3rd Standard	Air around us; air takes space; use of air.
4th Standard	Air has weight. Wind Force. Measurement of wind Direction and speed.

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*[1] Report on a session of technical panel set up at WMO and ESCAP on tropical cyclone: report given by Shri K.S.Chandrasekeran special Relief Commissioner in Orissa.

5th Standard	Composition of air and importance of water vapour.
6th Standard	Air pressure and its measurement. Barometer.
7th Standard	Use of air pressure. Typhoons
8th Standard	Gases in the atmosphere.

Articles by U Thu Ta

1. The Storm Season	Forward Magazine 1962
2. Ten Years Review of Storms in the Bay of Bengal.	Burma Science Association Magazine 1958
3. Bay of Bengal Storms	Book published in 1972.
4. General Meteorology	Book published in 1968.

Appendix 2.22 : Glossary of meteorological terms in languages of the coastal states[1]

2.382 GLOSSARY OF METEOROLOGICAL TERMS IN LANGUAGES OF THE COASTAL STATES IMPORTANT FOR CWMs :

In course of years a body of equivalents in the local languages of the coastal states for meteorological terms used in the CWMs have developed. Table 2.81 and 2.82 give a collection of these terms as found in current use. It will be realised that many more terms have to be added to the existing glossary.

TABLE 2.82

METEOROLOGICAL TERMS AND THEIR EQUIVALENTS IN VARIOUS LANGUAGES OF THE COASTAL STATES (IN ROMAN SCRIPT)

First group of coastal languages derived from Sanskriti

Sr. No.	English	Hindi	Bengali	Gujrati	Marathi	Oriya
1.	Centre		KENDRA	KENDRA	KENDRA	KENDRA
2.	Core of hurricane winds		ATI PRABAL JHATIKA HAOWA JUKTA ANTASTHALA	BHARI TOFANNO ANDARNO BHAG	TUFANI WARYACHA AATEEL BHAG	JHODEEYO POBONO-JUKTO ONTOS-THOLO
3.	Cyclonic Storm		GHURNI JHAD JHATIKA	VAYU CHAKRA	TUFAN MOTHE VADAL	JHADA
4.	Danger Signal		BIPAD SANKET	DHOKANO NAVATO	DHOKYACHA BAVATA	BIPODO SONKETO
5.	Depression		NIMNA CHAP KHETRA	TOFAN	VADAL	NIMAN CHAPA KHETRA
6.	Forecast		PURBABHASH	VARTARO	AANDAJ	PURBABHASSA PAGARA
7.	Gale		JHATIKA	PAVANNU TOFAN	SOSATYACHAWARA	JHARDA
8.	Great Danger Signal		BHAYANKAR BIPAD SANKET	MOTA DHOKANO VAVATO	MOTHYA DHOKYACHA BAVATA	GHORO BIPODO SONKETO

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*[1] Information provided by Dr.A.A.Rama Sashtry of IMD, Member of the Committee.

Sr. No.	English	Hindi	Bengali	Gujrati	Marathi	Oriya
9.	Heavy		PRABAL	BHARI	JORACHA	PRABALA
10.	High Sea		TARANGA BIKSHUBDHA SAMUDRA	UGHA MOJAWALO DARIYO	KHAVALALELA SAMUDRA	TARANGA BIKHYUBDHA SAGAR SAGAR
11.	Hurricane		ATI PRABAL JHATIKA,ATI PRABAL GHURNI JHAD	BHARI TOFAN	MOTHE TUFAN, ZANZAVAT	ATI PRABALA JHARDA
12.	Intensity		PRABAL HAOWA	JOR VADHIYUN	JOR WADHANE, TEEVRA HONE	PRABALA BHABARE
13.	Isolated		MATRA DUEK JAIGAI	KOIK STHALE (KYANK KYANK)	TURALAK	MATRA GOTAE DUTTA JAGARE
14.	Local Cautionary		STHANYA SABAHANI SANKET	STHANIK SAVDHANTANO VAVATO	STHANIK SAVADHAGIRICHA BAVATA	STHANIYO SOTORKOBANI SONKETO
15.	Normal		SWABHBIK	RASH	SARASAREE	SWABHABIKA
16.	Phenomenal Sea		ASAMANYA SAMUDRER ABASTHA	AASAMANYA DARIYO	TUFANI SAMUDRA	OSAMANYO SOMUDRABOSTHA
17.=	Rough Sea		UCHGHA TORANGA SANKUL SAMUDRA	TOFANI DARYYO	VADALEE SAMUDRA	UCHHA TARANG SANKULA SAGAR
18.	Scattered		BIKSHIPTA BHABE	KOIK KOIK STHALE(CHUTTA CHAWAYA)	VIKHURALELA	BIKHIPTA BHABARE
19.	Severe Cyclonic Storm		PRABAL JHATIKA	GHANU BHARE TOFAN	TEEVRA TUFAN	PRABALA JHADA
20.	Squally Winds		JHADO	VAVAZODAWALI HAWA	VASALEE WARE	DAMKA PABANA

Sr. No.	English	Hindi	Bengali	Gujrati	Marathi	Oriya
21.	State of sea		SAMUDRER ABASTHA	DARIYANI STHITI	SAMUDRACHEE STHITI	SOMODRORO OBOSTHA
22.	Storm Surge		JHADER JALA-UCHCHAS	VADALI VALE	VADALEE LAT	JHODOJATO JODOCCHVASO
23.	Weaken		MANDA, KAMJOR	NABALU PADVU	KAMAJOR HONE	DURBALA KARIBA
24.	Widespread		BYAPAK BHAVE	BADHI JAGAE	SARVATRA	BYAPAKA
25.	Tidal Waves		JAWARER	GHODA	BHARATEECHA LONDHA	JUARA DHEU

TABLE 2.82

Meteorological terms and their equivalents in various languages of the coastal states (in roman script)

Second group consisting of South Indian Coastal Languages

Sr. No.	English	Kannadda	Malayalam	Tamil	Telegu
1.	Centre	Kendra	Kendra Stanam	Maiyam	Kendramu
2.	Core of hurricane winds	ANTARIK CHANDAMARUT	KODUNGATTINTE ANDHARBHAGAM	MAIYAM CHANDAMAPUTHAM	BHAYANKARA PENU TUPHANU
3.	Cyclonic Storm	CHND MARUT	PUYAL KODUNGATTU	SUZHAL PUYAL	TUPHANU
4.	Danger Signal	AFAGHAT SANKET	APAYA CHINHAM	ABAYAM ARIKAYI	APHAYAM GURTU
5.	Depression	OTTADAD TAGGU	NIMNATHA	AZHAMANA	PADARA PATHAMU LEKA VAYUGUNDAM
6.	Forecast	MUNSOOCHANE	PRAVA CHANAM	MUNARIVUPPU	PAVANA BHAVISHYAM
7.	Gale	BIRUGALI	PAYKATTU	KADUM KATRU	THIVRA VAVUVU
8.	Great Danger Signal	BHAYANKAR AFAGAT SANKET	VALIYA APAYA CHINHAM	ADIGAMANA ABAYAM ARIKAYI	BHAYANKARA APHAYAM GURTU

Sr. No.	English	Kannadda	Malayalam	Tamil	Telegu
9.	Heavy	BHARI	SHAKTIYAYA	KADUMALYANA	BHAREE
10.	High Sea	ETTAR SAGAR	PERUM KADAL	PARUM KADAL	UTTARANGITHA SAMUDRAM
11.	Hurricane	SUNTAR GALI	KODUN GATTU	CHANDA MARUTHAM	BHAYANKARA THIVRAMINA TUPHAN
12.	Intensity	BALAWATTAGI	SHAKTI PPEDUKA	KADUMAIANA	THIVRAMAGU
13.	Isolated	VIRALAVAD	OTTAPPETTA	THANITHA	EKIKAMINA
14.	Local Cautionary Signal	STHANIK ECHARIKE SANKET	PRADESHIKA APAKADA CHINHAM	ABAYAM ARIKAI	STHNIKA HECHARIKA GURTU
15.	Normal	SADHARAN	KALA MENI	VIDIPHIPADIANA	SAGATU
16.	Phenomenal Sea	PRACHAND SAGAR	ASADHARANA KADAL	ASADHARANA KADAL	PRACHANDA SHAGARAM
17.	Rough Sea	KACHA SAMUDRA	KOLPIDICHA KADAL	KONINDALIKUM KADAL	SHUBDHA GHOSHITHA
18.	Scattered	ALIONDU, ELLONDU	DHURLABHAMAYI CHILA STALANGALIL	SIDHARI	AKKADAKKADA
19.	Severe Cyclonic Storm	ANEK SUNTAR, BIRUGALI	GHORAMAYA PUYAL KODUNGATTU	KADUMAYANA PUYAL KATRU	PENU TUPHANU
20.	Squally winds	KARKASHAVAD GALI	KOLILAKKAM ONDAKKUNNA KATTU	PUYAL GUNAMUIA KATRU	PENUGALI, LEKA VISURUGALI
21.	State of Sea	SAMUDRAD STHITI	KADALINTE AVSTHA	KADLIN THANMAI	SAMUDRA STHITI
22.	State of Sea	Samudrad STHITI	Kadalinte	KADLIN	SAMUDRA

Sr. No.	English	Kannadda	Malayalam	Tamil	Telegu
22.	Storm Surge	PRACHANDAVADALE	PUYAL KODUNGATTU,SRISHTIKKUNNA THIRA	PUYAL AALI	UPPENA
23.	Weaken	BALAHEENVAD	SHAYIKKUKA	KURIVU PADAL	BALAHINA MAGUTA
24.	Widespread	VISTARAVAGI HARADIRUV	PARAKKEYULLA	PRAVEIYA	BAGUGA VYAPTHAMINA
25.	Tidal Waves	BHARATADALE	VELIYETTATHODU ANUBANDHICHA THIRAKAL	PRAVAGA AALI	UPPEN KERATAM

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CHAPTER 3

The Recommendations of the Cyclone Review Committee (CRC)

3.0 RATIONALLE AND SUMMARY OF THE RECOMMENDATIONS OF THE CYCLONE REVIEW COMMITTEE (CRC) :

The Committee has proposed a Cyclone Plan for India for confronting cyclones from the moment they are detected upto the time when rehabilitation work ends. The Committee has suggested the formation of a high power standing Apex Cyclone Committee (ACC) for formulation, implementation and periodic review of the Cyclone Plan (CPL). It is hoped that this Committee will take up the work of the present Committee, after it has submitted its report, and advise the Government of India from time to time in all aspects of the cyclone problem and for all possible scenarios that may arise in a cyclone emergency. The Committee noted that certain parts of coastal India are very frequently visited by cyclones and it recommended that these be declared as Cyclone Prone Areas (CPARs). The Committee has examined the very elaborate cyclone monitoring system, which has been established over the years by the Indian Meteorological Department (IMD), in particular of the radar horizon round coastal India and the satellite surveillance techniques that have been added in recent years. The Committee appreciated the introduction of all these new techniques for monitoring cyclones but felt that the standard ground observations from the normal meteorological observatories and ship observatories should not be neglected. All the various monitoring techniques should complement each other to arrive at correct assessment of cyclones because each method has its limitations. Indeed there has been instances when cyclones of strong intensities have been missed altogether by all the different methods. In order to interpret the radar and satellite pictures of Indian cyclones quickly in terms of their intensities (central pressure falls) and maximum wind speeds and their three dimensional structures it is necessary to develop accurate diagnostic techniques by correlating the normal observations with results of probing the cyclones by instrumented aircrafts. The central pressure fall is an important parameter for predicting storm surge heights. The Committee noted the establishment of a high density cyclone reporting network of surface observatories known as the Cooperative Cyclone Reporting Network (CCRN) on the eastern coast of India after the 1977 Andhra Pradesh Cyclone. It was however felt that since these were not linked by WT links to the Area Cyclone Warning Centres/ Cyclone Warning Centres (ACWC/CWCs), they would not be very useful when they are needed most viz. during cyclones. With the introduction of the Data Collection Platforms (DCPs) and the INSAT communication network it should be possible in course of time, to replace these surface observatories of the CCRN by autonomous automatised DCPs. The Committee has recommended this. The Committee noted that some of the Cyclone Warning Radars (CWRs) are not always located near the ACWC/CWCs so that the meteorologists who have to make on the spot assessments of the cyclones at the ACWC/CWCs, have the disadvantage of not being able to view the radar pictures continuously. The Committee recommended that this lacuna should be removed as soon as possible. The Committee has recommended that all the cyclone assessment work should be centralised at a Cyclone Assessment Centre located at Delhi (CAC) though all the ACWC/CWCs should be empowered to take the final decisions about assessment/warnings. The Committee also noted that cyclone Assessment at Delhi could be done there easily because of the computer facilities at IMD units at Delhi, where all informations and observational data of a raging cyclone could be stored on real time and from where cyclone analysts at various warning centres of the IMD, including the ACWC/CWCs, could retrieve any information they desire in any format they may choose. The Committee has recommended that the radar horizon should be made more effective by the establishment of one more CWR on the Saurashtra coast and one more CWC to be located at Ahmedabad. The cyclone warning dissemination system appears to be quite complex, but it appears that there were doubts whether it worked efficiently. The logistic lacuna in the cyclone warning system seems to lie mainly in the vulnerability to cyclones of the land based telegram and telephone communication system. The Committee recommended that the P&T Department should makes special efforts to keep the communication links at the highest level of efficiency during cyclone regimes. The existing system of using the AIR channels to disseminate the Cyclone Bulletins (CBs) including the Cyclone Warning Messages (CWMs) and the Cyclone Advisories (CAS) appears to work very well and must continue and indeed be strengthened, for these channels are well familiar to all cyclone warnees. The first stage 'Cyclone Alert' warning must be sent by the concerned ACWC/CWC by the traditional land line telegrams which should pose no problem when the cyclone is still far away. The subsequent CWMs and CAs must be monitored by the warnees from the broadcasts by the AIR. Often this will be the only channel of communication available because of snapping of other channels. The Committee felt that when it relates to Cyclone Codes (CCs) of the coastal State Governments and to Community Preparedness Plans against Cyclones (CPPCs), much remain to be done. To enquiries about how much has been achieved in this respect, the response from the coastal State Governments was very poor. A copy of the Disaster Plan of Tamil Nadu State was received and subsequently a similar document of the Andhra Pradesh Government was supplied by the Committee. The Committee realised that each coastal state has its own special features so that there can not be the same CC for all these states. The CC which is a set of rules and procedures which must be followed in cyclone emergencies must have different characteristics for different states and must be incorporated in their General Disaster Plans (GDPs). The Committee has laid down some guidance for setting up the CCs in particular the Cyclone Emergency Action Plan (CEAP) and for the preparation of the CPPCs. Other highlights of the recommendations of the Committee are the recommendations for the formation of the State Cyclone Committee (SCYC), which would formulate the CEAP for the State and supervise its implementation and operation, and indeed would be the kingpin in the Cyclone Distress Mitigation Organisation (CDMO) of a coastal state. District Cyclone Committees (DCCs) have also been suggested, which would work under the supervision of the SCYC and take all executive actions during cyclone emergencies. For long range plans for preparing the community against threats of cyclones the Committee recommended that for each coastal state a Coastal Development Authority (CDA) be formed and all such responsibilities be given to it. The Committee has given some suggestions for formulation of the CEAPs and CPPCs and the functions of the CDAs. It is hoped that the coastal State Governments would find these suggestions useful in formulating their respective plans and in setting up of their CDAs. The importance of making the population of the CPARs aware of the nature and hazards of cyclones has been stressed. The Committee has also felt the need of continuing research on cyclones and resulting storm surges. All the recommendations of the Committee are serially numbered. The paragraph numbers under which they appear in the body of the report of the Committee are also given to enable their easy location in the main body of the report for understanding the background for making the recommendation. Many of the recommendations (marked X) are in the pipe line already. Some others(marked XX) have been implemented already, but are included here for sake of completeness. The recommendations are collected and appear in the next paragraph 3.1. It will be seen that the recommendations are grouped in two groups : Group A : Recommendations mainly for the IMD with respect to the CMS/CWS(CRC/1-1087) and Group B : Recommendations mainly for the coastal State Governments with respect to B.1 The Cyclone Code (CRC/108-231) and B.2 The Cyclone Preparedness Plan (CRC/232-309) and Group C : Recommendations for Research and Training (CRC/310-317).

3.1 COMPILATION OF THE RECOMMENDATIONS OF THE CRC

Group A: Recommendations mainly for the IMD with respect to the CMS/CWS (CRC/1-107).

I. Organisations for the formulation, implementation and review of the Cyclone Plan (CPL)

CRC/1 : It is the responsibility of the Indian Meteorological Department (IMD) to study in collaboration with the World Meteorological Organisation (WMO) the most modern practices being adopted in the world for predicting cyclones and storm surges and review from time to time the technical aspects of the current Cyclone Plan(CPL) of the country to incorporate these late techniques in it to the extent necessary and possible.

(Paragraph 2.9)

CRC/2 : An Apex Cyclone Committee (ACC) should be set up by the Government of India with the following terms of reference :

1. To implement the CPL in coastal India In particular to advise the incorporation of the Cyclone Code (CC) and the Cyclone Distress Mitigation Measures (CDMMs) in the General Disaster Plans (GDPs) of the coastal states of India. For this purpose the Committee

may invite social scientists, public health experts and those organisations that have experience in rescue, relief and rehabilitation works.

2. To advise the coastal states on long term measures for preparing the community against cyclones, some of which are improvements of dissemination systems for cyclones warning messages (CWMs), road and transport network, telecommunication network, establishing embankments against storm surges, improvement of water drainage and swerage systems, construction of cyclone shelters, protection of agricultural products, improvement of public health systems etc. Thus the ACC would help the coastal states to prepare their community Preparedness Plan against Cyclones (CPPCs).

3. To review periodically the CPL in the light of advance of scientific understanding of behaviour of cyclones and progress of techniques of cyclone monitoring and telecommunication.

4. To assess the extent of devastation caused by each cyclone in terms of loss of life and property after the cyclone has subsided.

5. To review the extent to which it was possible to monitor and predict the behaviour of each cyclone and assess the efficiency of the Cyclone Warning System (CWS) during its regime and to advise steps to remove lacunae if any.

6. To advise the Planning Commission to provide funds for additions of technological facilities as also for long term preventive measures to prepare the community against ravages of cyclones as suggested in the CPL.

7. To advise the Government of India on various legislative measures that may be necessary for introducing the CDMMs and various aspects of the CPL.

(Paragraph 2.11)

CRC/3 : The Government of India should provide adequate funds to the IMD for improvements of the Cyclone Monitoring and Warning Systems (CMS/CWS).

(Paragraph 2.13)

CRC/4 : Legislative measures should be taken to cover

1. Land use and zoning laws to restrict or prevent industrial and/or residential development in areas where cyclone risks are high e.g. low lying coastal areas exposed to storm surges. Such laws may cover taxation measures to stoor development away from the cyclone prone areas (CPARs). There may also be government actions to acquire land by compulsory purchases and to alter land use.

2. Enforcement of suitable building codes setting out minimum safety standards in areas vulnerable to cyclones.

3. Soil and plant conservation measures to guard against erosion of land caused by storm surges.

4. Engineering measures related to management and control of rivers, roads, canals and embankments, water drainage systems protection of agricultural products and various other similar problems arising out of cyclones.

5. Public health measures and sanitation systems - against air water pollution and for waste disposals, and epidemic controls etc.

6. Putting into operation the emergency measures recommended in the CC - evacuation from danger zones, emergency transport requisition and control thereof, mitigation of distress caused by cyclones and storm surges, rescue relief and protection of life, immediate financial relief to distressed persons.

7. Long term rehabilitation measures - restoration of buildings housing and installations, public service utilities including communications, transportations of all types, generation and distribution of electric power, repair of roads bridges dams dykes, embankments and harbours, immediate long term loans to distressed persons.

8. Social security measures - preservation of social order, protection of property of evacuees, and prevention of crime etc.

9. Replenishment of nationally owned stockpiles such as food, seed and medicine.

10. Utilisation of international credits and gifts and aids from abroad for mitigation of distress caused by cyclones.

11 Utilisation of various funds granted by the Government of India the concerned State Governments and charitable bodies for mitigation of the distress caused by cyclones.

(Paragraph 2.14)

II. Demarcation of CRARs of coastal India and consideration of terrains and seasons

CRC/5 : In the premonsoon season the period April to June and in the postmonsoon season the period September to December may be declared as cyclone seasons when the coastal State Governments Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal should be generally prepared for cyclones.

(Paragraph 2.17)

CRC/6 : Certain districts on coastal India as listed below may be declared as CPARs. Generally the CPARs may be demarcated be strips on the coast of width of about 25 km. The demarcation would depend on the topology, river systems, high lands/embankments and hydrodams near to the coast and should be done after the due consideration by the coastal State Governments. Landfall records of past cyclones reveal the following coastal districts of India as particularly vulnerable to such storms. While making the final declaration of the CPARs the IMD and the various flood forecasting centres of the Central/State Governments/IMD located in the concerned state may be consulted.

Cyclone prone districts

1. Andhra Pradesh East Godavari, Krishna, Nellore (including Prakasam), Shrikakulam

2. Orissa : Balasore, Cuttack, Ganjam. Puri

3. Tamil Nadu : Chingelput, Tanjavur

4. West Bengal : Midnapore, 24 Parganas

This list is by no means complete and each coastal State Government should consider which other areas in the State may be declared as CPARs.

(Paragraph 2.20)

CRC/7 : The flood forecasting centres of the Central Water Commission/State Irrigation Department/IMD should have at their disposals topological maps of the CPARs of the coastal regions of India prepared by the State Governments with contour lines at 1m intervals to prepare storm surge risk maps (SSRMs) to use for assessment from the storm surge height forecast in the Cyclone Warning Messages (CWMs), the possible extent of inundations, which information should be immediately available to the concerned public in the storm surge/flood forecasts and the Cyclone Advisories(CAs). This would enable the concerned District Cyclone Committee (DCC) to put into operation the appropriate measures.

(Paragraph 2.20)

III. Cyclone detection, observation and tracking methods and facilities in India.

III A Cyclone Data Collection Systems (CDCS)

IIIA(1) Surface Observatories (SOs)

CRC/8 : Since the most important parameters for cyclone assessment are pressure falls and wind velocities, all coastal surface observatories (SOs) of the IMD should be equipped with sturdy aneroid barometers and robust anemometers. Some selected SOs on the CPARs should be equipped with anemometers capable of measuring wind speeds upto 200 kmph. Efforts should be made by the IMD for indigenous development of such anemometers and towers for housing them capable of standing upto such winds.

(Paragraph 2.28)

CRC/9 : The part time SOs (PSOs) on coastal India should be converted ultimately into departmental SOs (DSOs) and provided with distant reading equipments for measuring winds, pressures and rainfalls. Such instruments should be developed by the IMD in collaboration wherever possible with the research and technical development organisation in India. The IMD must ensure the completion of conversion of PTSOs to PSOs in 3-4 years.

(Paragraph 2.29)

CRC/10: As the pace of conversion of PTSOs to DSOs is too slow, and as the observational network will have to depend on the PTSOs for some time, academic organisations should be involved in the running of these PTSO stations for better performance.

(Paragraph 2.29)

CRC/11: A few SOs at selected sites on coastal India should be automatised and made self telecasting on an experimental basis. For this purpose the IMD should develop the necessary technology in collaboration, wherever possible, with the research and technical development organisations in India.

(Paragraph 2.30)

CRC/12: The densities of SOs in the CPARs areas on Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal are inadequate and should be increased sufficiently to cover the needs of the CMs.

(Paragraph 2.32)

IIIA(2) Upper Air Observatories (UAOs)

CRC/13: The Upper Air Observatory (UAO) network on the west coast may be usefully strengthened by converting immediately the pilot Baloon Observations (PIBALS) at Bhuj, Veraval and Ratnagiri to Radiowind Observatories (RVOs).

(Paragraph 2.34)

CRC/14: Though the UAO network on coastal India may be just adequate, it is advisable to convert, in course of time all the coastal PIBAL observatories to RWO observatories or locate a few mobile RS/RW vans along the coast which can be moved into the affected areas.

(Paragraph 2.34)

CRC/15: The frequency of recording observations should be increased to four times daily at all RS/RW observatories when they come into the cyclone field.

(Paragraph 2.35)

CRC/16: Some of the METOX theodolites and the weather X-band radars at the UAOs are very old and have outlived their usefulness for wind determination at high levels of the atmosphere. They should be replaced by modern wind finding radars manufactured in the country by Bharat Electronics like Multimet radars, if their performance is satisfactory. Otherwise the replacements have to be done by import.

(Paragraph 2.36)

IIIA(3) Data Collection Platforms (DCPs)

CRC/17: The DCPs should have atleast ten primary meteorological oceanographic sensors for measuring : (1) air temperature, (2) wet bulb tempeature, (3) relative humidity, (4) wind speed, (5) wind direction, (6) atmospheric pressure, (7) DCP housing temperature, (8) rainfall, (9) sunshine and (10) sea surface temperature.

(Paragraph 2.41)

CRC/18: After the INSAT-1 programme is satisfactorily implemented, some of the coastal SOs in the areas, where cyclone landfalls are more frequent may be converted into automatic Data collection Platforms (DCPs) if necessary. The collected meteorological data may be then transmitted via the INSAT system on real time to the various warning/forecasting centres and data collecting centres of the IMD: Area Cyclone Warning Centres/Cyclone Warning Centres (ACWC/CWCs) and the Regional/State Collecting Centres(RCC/SCCs).

(Paragraph 2.42)

IIIA(4) Ship meteorological data (SMD)

CRC/19: All meteorological data (SHIP) collected by the ships of the Voluntary Observation Fleet (VOF) plying in the shipping lanes of the Arabian Sea and the Bay of Bengal should be gathered through the INMARSAT system. The necessary transmitting/receiving equipments may be installed in the chosen ships of the VOF by the concerned Shipping Companies. The weather data so collected should be transmitted expeditiously to the ACWC/CWCs and the RCC/SCCs.

(Paragraph 2.43)

CRC/20: A Maritime Meteorological Organisation should be set up in the IMD and located at some suitable centre to provide the following meteorological services: 1) Weather routing of ships, 2) Forecasting of the state of the sea, 3) Forecasting of sea surface temperature, 4) Information about layer depths, and forecasting the sea subsurface temperature in the fixed layers and 5) Weather forecasting services for fishing operations. At present all these activities are carried out at various places. There is need to coordinate these activities at one place under one organisation. Apart from providing these services, this organisation should also take up research on all aspects of marine climatology and marine weather forecasting and serve as the nodal point for data collection from the Oceanographic Research Vessels (ORVs).

(Paragraph 2.44)

IIIA(5) The Cyclone Warning Radars (CWRs)

CRC/21: The Cyclone Radar Horizon (CRH) round the Indian coast may be made more effective on the west coast by installing a Cyclone Warning Radar (CWR) at a suitable location on the Saurashtra coast.

(Paragraph 2.51)

CRC/22: There should be direct transmission facilities for radar pictures from the CWRs to their respective ACWC/CWCs when they are not both located at the same site. The ACWC/CWCs and the collecting centres should be interconnected with voice grade communication links and video channels for transmitting radarscope imageries on real time. The ACWC/CWCs should be equipped with facilities for video taping and playback systems and equipments for digitising the radar informations and arrangements for storage retrieval of these imageries.

(Paragraph 2.54)

CRC/23: A cyclone which has crossed into the CRH set at 400 km from the coast as determined by the normal range of the CWRs, should be kept under constant watch by these radars round the clock till it finally subsides.

(Paragraph 2.56)

CRC/24: While the capability of observation of wind structures within a cyclone by the Doppler radar is well realised, the technique is still under experimentation in USA and Japan and has not yet been put there into extensive operational use for cyclone monitoring. Moreover its usefulness in estimating the wind velocities at different levels in a cyclone system has yet to be established. A ground based Doppler Radar for cyclone monitoring was therefore not recommended. However as this was an emerging technique which may find many meteorological application for determination of velocities of wind and cloud masses, efforts may be made to make a beginning in the use of Doppler radar to study local storms like norwesters.

(Paragraph 2.57)

IIIA(6) Cyclone observation by satellites

CRC/25: The present Automatic Picture Transmission (APT) receivers manufactured by the IMD and employed in Satellite Monitoring of Cyclones (SMC) by the Polar Orbitting Satellites (POSs) need improvement and should be replaced by receivers of better performance to improve the quality of the cloud imageries received. It was noted that IMD has already entrusted the work to the Bharat Electronics (BEL).

(Paragraph 2.61)

CRC/26: The APT receivers at the ACWC/CWCs should be capable of receiving the infrared cloud imagery broadcasts by the POSs passing over the Indian region during night.

(Paragraph 2.61)

CRC/27: Since the pictures from the USSR meteorological satellites are received only at the Regional Telecommunication HUB (RTH) at Delhi, the IMD should arrange quick and prompt transmission of these pictures to the ACWC/CWCs.

(Paragraph 2.61)

CRC/28: The Very High Resolution Radiometer (VHRR) terminals set up at Satellite Application Centre (SAC) at Ahmedabad, the Meteorological Data Utilisation Centre (MDUC) at Delhi and the National Remote Sensing Agency (NRSA) at Hyderabad and any others that may be set up in the country, should be closely integrated with each other and with the neighbouring ACWC/CWCs for maximum efficiency for cyclone detection and assessment.

(Paragraph 2.68)

CRC/29: It is not advisable to set up VHRR terminals at the individual ACWC/CWCs. The expertise, analysis facilities and sophisticated technologies available at the various units of the IMD at Delhi are adequate for the purpose of analysis of satellite data on cyclones. The analysed data can be easily and immediately transmitted to the ACWC/CWCs by the telecommunication links of the IMD.

(Paragraph 2.69)

IIIA(7) Aircraft Probing of Cyclones (APC)

CRC/30: It is absolutely essential to prepare a classification of cyclones for the Indian region by correlating the measurements on the Indian cyclones by Cyclone Probing Aircrafts (CPAs) with the data from the cyclone imageries recorded by satellites and the CWRs. Such aircraft probing of cyclones (APC) are also important for microstudies of all cyclone parameters and detailed analysis of their structures and for improving the forecasting capabilities of the ACWC/CWCs. It is expected that such studies would lead to deeper understanding of cyclone dynamics - their formation, development, movement and decay and the setting up useful cyclone models.

(Paragraph 2.72)

CRC/31: The CPAs should be long endurance aircrafts with maximum range of 2500 miles and must be aerodynamically suited to stand up to the stresses of flights through cyclonic conditions. Four engine turboprop aircrafts are usually used for cyclone probing and may be used to study Indian cyclones also.

(Paragraph 2.73)

CRC/32: The CPAs should have the capability of installing a belly radar in it. The following instrumental facilities were suggested for installation in the aircraft:

1. Instruments for measurement of meteorological parameters:

a) total/free air temperatures, b) atmospheric pressure - static, c) atmospheric pressure-differential, d) pitot head, e) flight level wind, (f) dew point, g) sea surface temperature, h) wind, i) temperature-vertical profile, j) humidity-vertical profile, k) pressure-vertical profile, l) radar altitudes.

2. Instruments for cloud physics : a) cloud liquid water contents, b) total liquid water contents, c) hydrometeor size spectra (cloud droplets/hydrometeors)

3. Suitable meteorological radars: a) belly radar C-band PPI 360° scan (horizontal) fan beam radar, b) nose radar for weather RCA AVO 30, c) nose radar C-band PPI 240° scan (conical)

4. Onboard photographic systems : a) sea state photography (looking down), b) time elapse cloud photography (side looking), c) data panel photography. d) radarscope photography recording.

5. Onboard data recording system : a) Two recording systems-one dedicated to meteorological cloud physics, radiation sensors and lN system, and the other to the nose and lower fuse lage, b) a suitable onboard minicomputer and necessary peripherals.

(Paragraph 2.73)

CRC/33: For planning the Aircraft probing of cyclones (APC) a Directorate of APC should be established with the necessary support from the IMD to take decisions on probing flights, flight plans, installation/procurement/maintenance of instruments abroad the CPAs and to interpret the results of observations and to transmit the results to the forecasting centres including the ACWC/CWCs.

(Paragraph 2.73)

CRC/34: For telecommunication (TC) linkage with ground stations the IMD should be assigned special frequencies for use to establish two way communication between the CPAs and the base stations on ground

(Paragraph 2.73)

CRC/35: The CPAs may be used during non cyclonic seasons for other atmospheric studies like investigations of monsoon depressions, cloud physics, sea state studies etc.

(Paragraph 2.73)

CRC/36: The maintenance and operations of the CPAs should be given to agencies like the national Remote Sensing Agency(NRSA) or to the Indian Air Force(IAF)

(Paragraph 2.73)

CRC/37: Proper training of the CPA mission scientists, technicians, and crew members should be organised as done in the Research Flight Centre (RFC) at Miami USA. The training should include flying the aircraft under cyclonic conditions, planning probing flight patterns in the field of the cyclones, conducting meteorological experiments under cyclonic conditions and interpreting data thus acquired and other similar tasks that would be necessary.

(Paragraph 2.73)

CRC/38: The CPAs may be acquired as expeditiously as possible.

(Paragraph 2.73)

CRC/39: More than one APC may be necessary for probing a cyclone. These may be acquired gradually in phases under the aegis of the WMO/ESCAP Panel on tropical cyclones as a part of a regional project.

(Paragraph 2.74)

IIIA(8) Other emerging techniques of studying cyclones and surrounding neighbourhood

CRC/40: There is need to develop expertise by the IMD on the investigation of the state of the sea by downward looking lasers by sending its scientists abroad for training. The instrument packet aboard the CPAs may be reinforced by the addition of these laser equipments.

(Paragraph 2.75)

CRC/41: The IMD may organise research programme with various research groups in the country to investigate the possibility of using a HF radar in the ionosphere scatter mode to study the state of the sea and correlate it with the parameters of a cyclone in the area.

(Paragraph 2.75)

CRC/42: Data on the swells on the sea as observed on ships should be regularly reported to the ACWC/CWCs when they are of a nature indicative of cyclone formation.

(Paragraph 2.75)

IIIA(9) Rain Gauge/Storm Gauge Stations(RGs/SSGs) in coastal India.

CRC/43: The Ordinary Raingauges(ORGs) used in the CPARs should in course of time be replaced by Self Recording Rain Gauges (SRRGs).

(Paragraph 2.77)

CRC/44: The tide measuring instruments set up at the Tide Gauge Stations (TGSs) on the coastal regions of India should be strengthened to be able to stand up to the fury of the cyclones. The instruments for measuring tide levels should be redesigned to be able to measure cyclonic storm surges.

(Paragraph 2.79)

CRC/45: For the purpose of cyclone assessment and warning more TGSs have to be installed particularly in the river estuaries and littoral areas and specially in the island groups in the river delta regions as also in the areas notorious for cyclone landfalls.

(Paragraph 2.80)

CRC/46: The intercommunication between the ACWC/CWCs and the Collecting Centres with the TGSs,should be improved so that they function without fail during cyclone regimes.

(Paragraph 2.81)

CRC/47: The IMD should colaborate with the National Institute of Oceanography (NIO) to design/develop/fabricate a new generation of self recording storm surge gauges (SSGs) capable of measuring ; 1) maximum storm tide level reached, 2) direction of storm surge movement, 3) velocity of storm surge rush, 4) pressure exerted by storm surge, 5) wave structure of the storm surge and 6) automatic timing of recording these data. The R&D should also involve the design/development/construction of structures on land/river/offshore sea, housing the SSGs capable of standing upto the violence of cyclone caused storm surges.

(Paragraph 2.82)

CRC/48: An important task of the ACWC/CWCs should be to collect and archieve in a routine manner the data on storm surges for the areas under their control. A cyclone storm Surge Research Centre may be established within the IMD to assess/analyse these data on storm surges collected by the ACWC/CWC for research investigations with objectives to understand the storm surges and improve the techniques of their forecasting.

(Paragraph 2.83)

IIIA(10) Exchange of Informations with Cyclone Centres in neighbouring countries.

CRC/49: In the interest of better functioning of cyclone monitoring and warning systems established in India, it is desirable that close colaborations are established between the ACWC/CWCs of India and the CWCs of Bangladesh, Burma, Malaysia, Pakistan and Shri Lanka.

(Paragraph 2.84)

III B. Statistical data on cyclones in India and Climatology

CRC/50: The frequency distribution of cyclone landfalls over coastal regions of India at 5 years interval should be periodically updated by the IMD.

(Paragraph 2.85)

CRC/51: Statistics of the return period of cyclones over each coastal regions of India with an assessment of the vulnerability of these localities to cyclones should be prepared by the IMD.

(Paragraph 2.85)

CRC/52: The Cyclone Atlas prepared by the IMD should be updated upto 1980 and may be widely circulated. It should show the tracks and include accounts of a selection of some particularly devastating cyclones occuring in India.

(Paragraph 2.85)

CRC/53: The IMD should prepare an Atlas of satellite imageries of Indian cyclones collected over the past decade and prepare individual analysis of structures/movements and classifications of those cyclones based on their satellite pictures. This would provide materials for preparing cyclone models in developing theories of cyclone formation/evolution.

(Paragraph 2.85)

CRC/54: The satellite pictures of Indian cyclones collected by the IMD should, in course of time, provide sufficient data to prepare a climatology based on the statistics of all cyclone eye formations in the Indian region, associated derived wind fields and pressure depths.

(Paragraph 2.85)

CRC/55: The IMD should build up an archive of microfilmed informations on cyclones over the Indian region based on the earlier studies of the Department, on current observations carried out through whatever techniques employed and the microfilmed satellite cyclone imageries collected by USA and other countries for the period from 1960 onwards. The archive should also contain the whole history/analysis of these cyclones and should be a reference centre for researchers on cyclones.

(Paragraph 2.86)

IV. The Cyclone Warning System (CWS) in India

IV A Data Collection/Analysis/Forecasting Centres of the IMD for cyclones

CRC/56: Since the NHAC-Delhi receives all meteorological data from all Indian collecting centres and the ACWC/CWCs, the analysis of the data for cyclone assessment should be concentrated at this centre only. For this purpose it is necessary to ensure that all informations regarding cyclones from the Coastal Meteorological Observatories/Island Meteorological Observatories(CMO/IMOs), SO/UAOs ships, DCPs, CWRs and the satellites are promptly received at the NHAC on real time through the existing Message Switching Computer installed there. The NHAC should also have a computer of large storage capacity where all those messages can be stored and be instantly available, processed in any format desired by the cyclone analysist/user whenever needed for assessment purposes.

(Paragraph 2.89)

CRC/57: The IMD should advise the Apex Cyclone Committee (ACC) on various technical aspects of long term measures for preparing the community for cyclones. It should also advise the ACC on the formulation of cyclone codes (CCs) for the coastal states and their updating in the light of gathering experience.

(Paragraph 2.89)

CRC/58: The IMD should set up a Cyclone Assessment Cell(CAC) at Delhi dedicated to coordinating and evaluating the incoming data from the ACWC/CWCs and the Regional/State Collecting Centres(RCC/SSCs) and other data centres

(Paragraph 2.92)

CRC/59: All the INSAT meteorological data processed at the Meteorological Data Utilisation Centre (MDUC) at Delhi should be transferred to all the Secondary Data Utilisation Centres (SDUCs) particularly to those situated at the ACWC/CWCs.

(Paragraph 2.95)

CRC/60: A Cyclo Warning Centre (CWC) may be established at Ahmedabad for more effectively operating the Cyclone Warning System (CWS) on the west coast of India.

(Paragraph 2.97)

CRC/61: Officers and other cadres working in ACWC/CWCs should be provided quarters within the premises of these centres. Questions of work leave, building up of reserve personnel and improvements of working conditions of the staff should be considered so as to minimise the fatigue of long hours of work. The consequent administrative problems arising should be solved by the IMD. Similar facilities may be provided to officials of other government agencies/departments involved in CMS/CWS.

CRC/62: As the tasks/responsibilities of the ACWC/CWCs are steadily rising, it is necessary to change the staffing pattern at these centres so as to strengthen the staff there and reduce the heavy pressure of work that has to be met.

(Paragraph 2.101)

CRC/63: Each ACWC/CWC should be equipped with suitable minicomputer to process the incoming data on cyclones from the CMO/IMOs for transmission to the CAC at Delhi. The minicomputer should alsohave automatic data and message handling capabilities, large storing facility and the peripherals for immediate display/print outs as required.

(Paragraph 2.102)

IV B Cyclone Data Collection/Dissemination/Warning Systems

IV B(1) Centres for dissemination of national/international meteorological data

CRC/64: All the ACWC/CWCs should be equipped with RTT systems and facilities for receiving FAX broadcasts from the Regional Telecommunication Hub (RTH)-Delhi.

(Paragraph 2.109)

IV B(2) Data collection/communication via INSAT-1 and the DCPs

CRC/65: For the purpose of collection of cyclone data and dissemination of Cyclone Warning Messages it would be sufficient to establish via INSAT-1 S and C Band capabilities two way communication links between the MDUC, the ACWC/CWCs and the DCPs. The Earth Stations necessary for this purpose may be established.

(Paragraph 2.115)

IV B(4) Telecommunication Systems used for the Cyclone Warning System (CWS)

CRC/66: Since the P&T TCCs form a vital part in the successful operation of the Cyclone Data Collection System (CDCS) and the cyclone Warning System (CWS), the P&T Department should establish a special cell for improvement/maintenance/supervision of these TCCs so that these can function at the level of maximum efficiency.

(Paragraph 2.118)

CRC/67: The Cyclone Warning System (CWS, set up by the IMD should be progressively based on telecommunication systems (TCCs) like Wireless Telegraphy (WT), Radio Telephoney (RT) and Radio Teletype (RTT), Facsimile (FAX) transmission system, Very High Frequency/Ultra High Frequency (VHF/UHF) communication systems and Microwave systems all of which are comparatively imune to cyclones. The INSAT system should also be rapidly put into operation to supplement the other TCCs used in the CWS.

(Paragraph 2.120)

CRC/68: It would benefit the Cyclone Data Collection System (CDCS) and the Cyclone Warning System (CWS) of the IMD if the P&T Department establishes reliable cyclone proof TC linkages between the P&T communication centre in each coastal state and the various data collection/forecasting centres of the IMD of which the most important in the matter of cyclones are the ACWC/CWCs.

(Paragraph 2.120)

CRC/69: The P&T Department should provide to the IMD UHF and Microwave telecommunication channels on lease, High priority for this project should be given to create a network for the Cyclone Warning System (CWS) in the CPARs of India. For this purpose considerations of economic viability should not stand in the way.

(Paragraph 2.121)

CRC/70: The Railway microwave network set up on the east coast and the Aeronautical Fixed Telecommunication Network (AFTN) system of the Civil Aviation and Tourism Department should be used in periods of extreme cyclone emergencies when all the normal TC channels have failed.

(Paragraph 2.122)

IV B(5) TCCs for the ACWC/CWCs

CRC/71: The weather telegraph offices (WTO) of the P&T should also be located within the premises of the CWCs as has been done for the ACWC.

(Paragraph 2.126)

CRC/72: When the proposed CWC at Gujarat is established it should be provided with reliable TC systems as the other ACWC/CWCs.

(Paragraph 2.129)

CRC/73: All the CMO/IMOs should in course of time be equipped with their own WT/RT facilities for communication with the corresponding ACWC/CWC for transmitting to it the meteorological data collected by them. The ACWC/CWCs also should be similarly equipped to communicate with the CMO/IMOs under their control.

(Paragraph 2.129)

CRC/74: The CWRs at Karaikal, Masulipatnam and Paradeep should be connected to the corresponding ACWC/CWCs by HF linkage.

(Paragraph 2.131)

CRC/75: During a cyclone regime, the P&T Department should position its maintenance staff within the ACWC/CWCs and other concerned meteorological offices for prompt and speedy rectification of faults in the telecommunication channels or their restoration in case of breakdown of communications.

(Paragraph 2.132)

CRC/76: The P&T and the AIR coastal Radio Stations with transmitters upto 10 KW power should have stand by diesel generator sets. The CMO/IMOs using IMD WT/RT channels may also be provided with similar standby generators.

(Paragraph 2.133)

IV B (6) TCCs for Tide Gauge Stations

CRC/77: If the experience of the DCPs telecasting their informations via the INSAT system to the ACWC/CWCs and the RCC/SCCs is encouraging, then the IMD may consider setting up its own network of automatised and self telecasting Tide Gauge Stations at selected points in cyclone prone areas which are vulnerable to storm surges. A beginning may be made with a few experimental stations in Andhra Pradesh and West Bengal.

(Paragraph 2.134)

IV C Cyclone Services

IV C(1) The Cyclone Warning Agencies/Warnees

CRC/78: An organisation should be created and located at the IMD Head Quarters at Delhi. which is dedicated to coordinate/supervise the totality of the Cyclone Working Programme. A Cyclone Warning Directorate (CWDR) at Delhi may serve this purpose. One of the tasks of this body should be to guide the work of the Cyclone Assessment Cell (CAC) proposed by this Committee in CRC/61.

(Paragraph 2.135)

IV C(2) Cyclone Warning Messages/Cyclone Advisories/Cyclone Bulletins (CWM/CA/CBs)

CRC/79[1]:For the CWMs it may be more convenient for the public to grasp the magnitude of cyclones if they are classified under three categories according to wind speeds in the cyclone fields : 1) Depression (32-50 kmph), 2) Toofan (51-89 kmph) and 3) Severe Toofan (89 kmph and above). The use of the common Indian word Toofan in place of the word cyclone is expected to be more effective and meaningful to the general categories of warnees.

(Paragraph 2.142)

CRC/80: All cyclones should be serially numbered : Cyclone : Year : X, Month : Y, Serial Number : Z. Later when the landfall point is known, the geographical characterisation of the landfall point may be added after the serial number : Landfall Point : A, State : B.

(Paragraph 2.143)

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* [1] The IMD did not accept the classifications which does not conform to the international practice.

CRC/81: The CWMs and the Cyclone Advisories (CAs) should be drafted in layman's terms in the various local languages of the coastal states. A glossary of meteorological terms in these languages should be evolved for this purpose.

(Paragraph 2.144)

CRC/82: The CWMs and the CAs for the rural and the urban areas should be suitably reformated to suit the special needs of the local community and the special features of the terrain.

(Paragraph 2.145)

CRC/83: The various types of informations/advisories related to cyclones should be broadcast for the public in a cyclone affected area in two categories :

1. The Cyclone Warning Messages (CWMs) for special groups of warnees containing various informations/forecoasts about an impending cyclone and accompanying storm surge. This part should be issued by the concerned ACWC/CWC and broadcast by the AIR

2. The Cyclone Advisories (CAs) which should contain informations/instructions/orders about measures of precautions/protection/evacuation/rescue/sheltering and camping/relief/rehabilitation. This part should be issued by the concerned District Collectors at his Cyclone Control Room and conveyed to the different groups of affected population/action teams of the concerned State Government through various communication channels of the latter. Collectively the two parts should be referred to as the Cyclone Bulletins (CBs).

(Paragraph 2.146)

CRC/84: Forecasts of storm surges should be an integral part of the CWMs and CAs and these should be made areawise in the cyclone affected regions. Forecasts should specify clearly which areas are likely to be inundated under storm surges and also the times when such surges are to be expected.

(Paragraph 2.147)

CRC/85: The storm surge warnings/advisories broadcast during cyclone emergencies should be modelled on flood warnings/advisories.

(Paragraph 2.148)

CRC/86: The CWM part of the CB may be put in the following format :

FORMAT 1

Format for the CWM part of the Cyclone Bulletin

1. Authority of issuance of the CWM
2. Serial Number of the Cyclone
3. Serial Number of the Cyclone
4. Date/time of issuance of the CWM
5. Description of the Cyclone -
    - a) Classification of the cyclone
    - b) Last location
    - c) Direction of movement
    - d) Maximum Wind Speed
    - e) Expected landfall·
        - i) Area
        - ii) Date/time
6. General Warnings to the public about wind speed(km/hr) Rainfall(mm), Storm Surge(m) and state of the Sea Surface for (a) Area of great danger (AGD), (b) Area of danger(AD) (c) Area of alert (AA).

(Paragraph 2.150)

CRC/87[1]:The visual storm signals demonstrated at the sea ports should directly be correlated to the three classifications of cyclones : Depressions (32-50 kmph), Toofan (51-89 kmph) and Severe Toofan (89 kmph and above).

(Paragraph 2.151)

IV C(3) Dissemination of Cyclone Warnings

IVC(3.1) Cyclone Warning Dissemination (CWD) by P&T TC Channels

CRC/88: The first stage cyclone warning signal - Cyclone Alert must be sent by the concerned ACWC/CWC to all cyclone warnees by land based telegrams. It is important to ensure that this warning is transmitted to the Chief Secretary of the affected state without any wastage of time by "Weather Immediate" telegrams, which bear the priority code 000 and also by telephone so that the Cyclone Code (CC) can be put into operation immediately. The AIR, being the organisation ultimately responsible for dissemination of Cyclone Bulletins (CBs) containing the Cyclone Warning Messages (CWMs) and the Cyclone Advisories (CAs) to all cyclone warnees and the affected public, should be able to get the CBs at the highest priority from the concerned ACWC/CWC on the fastest TC channel available. The P&T Department must ensure that the communication links from the concerned ACWC/CWC to the office of the Chief Secretary and the AIR stations do not snap in a cyclone emergency, or if they do the P&T Department should repair/restore the communication link immediately or set up alternative TC links so that the dissemination of the CBs is not interrupted/impeded.

(Paragraph 2.166)

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[1] As mentioned under CRC/81 the IMD did not accept this classification of storms.

CRC/89: Though the ACWC/CWCs must make all attempt to disseminate the CBs containing the CWMs and the CAs to all cyclone warnees by whatever means that is available in a cyclone emergency as expeditiously as possible, it may be quite possible that it fails in doing this task because of the snapping of some TC link. After the first stage 'Cyclone Alert' signal has been received on the normal TC links from the concerned ACWC/CWC which will be generally possible because this signal will be issued quite some time before the cyclone arrives, the cyclone warnees should be advised to rely more on the CB broadcasts of the AIR for the latest upto the hour informations/ advisories about the cyclone. The affected population should be advised that the CBs broadcast by the AIR are the only reliable informations about the cyclone that are available.

(Paragraph 2.166)

CRC/90: Since the landline telegrams (LLTs) are a vital part of the Cyclone Warning Dissemination System and since the general experience is that the cyclone warning telegrams (CWTs) often fail to reach the warnees in the stipulated time not withstanding the priority codes marked on them, the P&T Department should examine the problem and remove the lacunae of the system and ensure that the communication system works efficiently. During the cyclone regime standby hot lines should be provided by the P&T Department between the ACWC/CWC, AIR, office of the Chief Secretary of the affected State, Cyclone Control Rooms at the district headquarters, and at the P&T coastal radio stations.

(Paragraph 2.166)

CRC/91: The ACWC/CWCs should establish close liason with the different Flood Forecasting Centres of various agencies in the State for prompt exchange of warnings so that they are in a position to assess the cummulative effect of the already standing waters and floods and the cyclonic storm surge, and then to utilise the data for the subsequent warnings. For this purpose it is essential that reliable TC channels are established between the ACWC/CWCs, the Flood Forecasting Centres and the Secretariate of the Irrigation Departments in the coastal states of India.

(Paragraph 2.167)

CRC/92: There should be standing orders by all coastal State Governments, that their Police WT system is put at the disposal of the concerned ACWC/CWC without any loss of time for CWD work if such a request is made by the latter to the Chief Secretary of the State during a cyclone emergency.

(Paragraph 2.168)

IV C(3.2) CWD through the INSAT system

CRC/93: The Disaster Warning System (DWS) part of the INSAT programme should be established as early as possible to provide an alternative cyclone proof TC link between the ACWC/CWCs and the cyclone warnees.

(Paragraph 2.170)

CRC/94: The responsibility of providing the DWS receivers and their repair and maintenance must rest with the IMD. But the responsibility of daily operation of these instruments must rest with the concerned coastal State Government.

(Paragraph 2.170)

CRC/95: It would be very useful to link up the Police WT system with the DWS system to disseminate CWMs and advisories for evacuation, rescue and relief (ERR) operations during a cyclone regime.

(Paragraph 2.170)

IV C(3.3) CWD through All India Radio (AIR)/Doordarshan

CRC/96: The first stage 'Cyclone Alert' warning signal should be broadcast 5 to 6 times daily as now, but when the cyclone has crossed into the CRH, the subsequent cyclone warnings should be broadcast hourly or half hourly round the clock for the benefit of listeners living in the areas where the landfall is expected(areas of Danger and Great Danger (AsD/AsGD). There should be more complete and upto the hour CBs broadcast from this stage onwards containing CAs from the State Authorities regarding precautionary measures to be taken by the public and evacuation/rescue/relief(ERR) decisions progressively taken by the State authorities.

(Paragraph 2.171)

CRC/97: After the cyclone has landfalled and weakened the ACWC/CWC must as soon as possible issue the 'Cyclone Dewarning' message to the AIR stations for broadcast to the public.

(Paragraph 2.172)

CRC/98: After the cyclone is over the AIR stations should continue to broadcast as long as necessary, the CAs of the concerned State authorities regarding evacuation, rescue, relief and rehabilitation (ERRR) measures taken by the State authorities.

(Paragraph 2.173)

CRC/99: When the cyclone has crossed the CRH, the frequency of broadcast of fishery warnings and coastal wheather bulletins should be increased. It would be desirable to broadcast these warnings not only in the regular Home News Service of AIR in the regional languages of the coastal states but also, as and when necessary, from the local AIR stations in the affected states in the languages of the local speeches. 'Nil Warning' messages should be broadcast as usual.

(Paragraph 2.174)

CRC/100:Meteorological Liaison Offices should be established at maritime states to interpret to the fishermen/groups of fishermen/ fishermen colonies/fishing cooperatives about the significance of the cyclone warnings issued by the ACWC/CWC over the AIR for fishing interest

(Paragraph 2.176)

CRC/101: It should be imperative for each or groups of fishing craft to carry suitable transistor radios for receiving the CWMs and the CAs. These may be provided/let out under hire to these users by the concerned State Governments.

(Paragraph 2.177)

CRC/102: Designated officials in the State and Central Governments should possess facilities to monitor the CBs broadcast by the AIR stations.

(Paragraph 2.178)

CRC/103: For monitoring the CB broadcast of AIR Transistor radios should be provided to 1) designated officials of the coastal State and the Central Governments located in the rural areas and 2) Headmen of hamlets and village Pradhans of Gram Panchayats and Sarpanches, who are entrusted by the District Collectors with the responsibility of disseminating CWMs and the CAs and various other tasks for protection of public life.

(Paragraph 2.179)

CRC/104: The range of audibility of the AIR stations in the coastal states should be reviewed periodically to the extent possible, to ensure that it is possible for all listeners in the CPARs on coast to receive clearly the CB broadcasts.

(Paragraph 2.181)

CRC/105: After the cyclone has crossed into the CRH it may become necessary for the AIR to broadcast its CBs to the public round the clock. The necessary arrangements should be made by the authorities of this organisation.

(Paragraph 2.182)

CRC/106: During a cyclone regime, the Doordarshan should show to the viewers satellite picturess of the evolution of the cyclone and its movement with time. After the cyclone has dissipated, the sequence of time elapsed pictures of the cyclone should also be shown. This is for all viewers in the cities and the village communities. In this way it is hoped that a greater awareness will be created among the public about the nature/hazards of cyclones.

(Paragraph 2.184)

IV C(3.6) Periodic testing of the CWD system

CRC/107: To test the efficiency of the Cyclone Warning Dissemination System (CWDS), surprise mock tests should be carried out periodically jointly by the IMD, P&T Department, AIR, State Government and various agencies concerned with CWD, at least once a year during the non cyclonic seasons. The results of such tests should be utilised to remove any lacunae of the system and strengthen the weak parts if any.

(Paragraph 2.189)

Group B.1 : Recommendations mainly for the Government of India and the coastal State Governments with respect to the National Cyclone Code and the Cyclone Emergency Action Plans.

V. Suggestion for formulation of a National Cyclone Code(NCC)

V.A Present status of Cyclone Codes(CCs) in the coastal states

CRC/108 : The Government of India should establish a National Cyclone Code (NCC) for the country by legislation in order that the coastal State Governments may use it for guidance for preparing their Cyclone Emergency Action Plan (CEAP).

(Paragraph 2.191)

CRC/109 : The coastal State Governments who have yet to formulate their Cyclone Emergency Action Plans (CEAPs) should do so as early as possible for laying down rules/procedures for actions/measures to be taken in a cyclone emergency for mitigating the distress caused. The CEAPs may be based on the recommendations of the Committee with respect to a National Cyclone Code. The State CEAPs should be included as a chapter in the State General Disaster Plan. The coastal State Governments should publish their CEAP manuals for use by their officials during a cyclone emergency.

(Paragraph 2.194)

V.B The Cyclone Distress Mitigation Organisation(CDMO)

CRC/110 : The coastal State Governments should each create a permanent cell under a Commissioner for Cyclone Rescue Relief and Rehabilitation (CCRRR) to supervise all Rescue/Relief/Rehabilitation (RRR) operations required for a cyclone emergency. The Commissioner may be given the rank of an ex-officio Secretary in the State the CCRRR Cell in colaboration with the proposed Coastal Development Authority may organise construction of roads/bridges/Cyclone Shelters/Cyclone Stores, enforce building codes and undertake the necessary operations for public health maintenance and supervise public health engineering measures to keep the community prepared for cyclones.

(Paragraph 2.199)

CRC/111 : A senior officer from each of the departments of the State Government concerned with Evacuation/Rescue/Relief/Rehabiliation (ERRR) works related to a cyclone emergency should be appointed to liase with the CCRRR continuously in various matters arising at different times during the emergency. These liasing officers would relay appropriate advisories/orders from the senior officers of their respective departments to the field officers regarding the latter's duties/functions/specific tasks at all stages of the disaster, before/during/after.

(Paragraph 2.200)

CRC/112 : Each coastal State Government should set up its State Cyclone Committee (SCYC) which should be in the nature of a Standing Committee to implement/organise all the cyclone distress mitigation measures (CDMMs) in the coastal areas encoded in its CEAP to limit the loss of life and property under onslaught from cyclones and mitigate the distress brought about by them. The SCYC should be the Apex body controlling all aspects of cyclone distress mitigation work (CDMW) in the State.

(Paragraph 2.201)

CRC/113 : The composition of the State Cyclone Committe (SCYC) **should** be as appropriate for the State on the lines indicated hereunder.

Chairman : Chief Secretary
Member Secretary : Commissioner - Cyclone Rescue Relief and Rehabilitation (CCRRR)

Members :

A. State Government

1. Agriculture and Community Development Department : Secretary
   Director - Agriculture
2. Animal Husbandry Department : Secretary
   Director : Animal Husbandry
3. Civil Defence Department : Secretary
4. Civil Supplies Department : Secretary
   Commissioner : Civil Supplies
5. Finance & Planning Department : Secretary
6. Fisheries : Secretary
7. Forest and Rural Development Department : Secretary
8. General Administration Department - Joint Secretary
9. Home Department : Secretary
10. Director : Home Guards
11. Irrigation and Waterways Department : Secretary
    Chief Engineer - Major Irrigation
12. Panchayat Raj Department : Secretary
    Chief Engineer : Panchayat Raj
13. Police Department : Secretary
    Director General: Police
14. Power Generation Department : Secretary
    Chief Engineer; State Electricity Board
15. Public Health Department : Secretary
    Director - Medical and Public Health Services
16. Public Health Engineering Department : Secretary
    Chief Engineer - Public Health
17. Revenue Department : Secretary
    Commissioner : Land Revenue
    Chief Collector - Revenue
18. Chairman : Coastal Development Authority
19. Roads, Transport and Buildings Department: Secretary
    Chief Engineer - Public Works Department
    Chief Engineer - Roads
20. Refugee Relief & Rehabilitiation Department : Secretary
    Commissioner - Relief.

B. Central Government

1. The Central Water Commission : Director of Flood Forecasting Organisation in the State.

2. Coast Guards : Director

3. Defence Establishments in the State -

   a) Army Commander in the State subsector
   b) Navy Commander in the State subsector
   c) IAF Commander in the State subsector

4. Indian Meteorological Department : Director of the concerned ACWC/CWC except during a cyclone emergency.

5. Indian Posts & Telegraph Department :

   a) Director General - All India Radio(in the State Capital).

   b) General Manager - Telecommunication (in the State Capital).

   c) General Manager - Telephones(in the State Capital)

6. Railways : General Managers of the Railways passing through the CPARs of the State.

7. Shipping and Transport Ministry : Chief Officer of the Port Authority in the State.

C. Legislature

1. One member from the Loksabha from the State
2. One member from the Bidhansabha

D. Voluntary Relief Organisations

1. Chairman of the branch of the Indian Red Cross Society in the State

2. Representative from other voluntary relief organisations active in the State.

(Paragraph 2.201)

CRC/114 : The terms of reference of the SCYC should contain interalia the following powers and responsibilities.

1. To set up standing District Cyclone Committees(DCCs) for taking emergency executive measures during cyclone regimes.

2. To establish and maintain snap proof TC channels of communication with the DCCs for despatching advisories for precautionaries, instructions/orders for ERRR and for receiving back reports on the actions taken.

3. To formally declare areas of the coastal regions as areas of Great Danger (area of likely landfall), Danger and under Alert : AGD, AD, AA.

4. To define and allot specific tasks to various departments of the State/Central Government and various agencies/voluntary organisation for the CDMW at various stages of the cyclone emergency and monitor on the progress of their efforts.

5. To mobilise the resources in men, materials and equipments of the State/Central Government and various agencies/voluntary organisations or that available from the public for the CDMW.

6. To advise the State Government about compulsive evacuation from identified AsGD during a cyclone.

7. To review periodically the Cyclone Emergency Action Plan (CEAP) for the concerned State in the light of the experience gained with the objective to remove the lacunae if any.

CRC/115 : As soon as a cyclone emergency develops the Control Room General Administration (CRGA) should be placed under the control of CCRRR and manned by officers of the Departments of Revenue, Police and Defence, and representatives from the IMD if available during the emergency. The CRGA should be connected by reliable TCCs to the departments involved in Cyclone Distress Mitigation Work CDMW and with their field stations in the Cyclone affected areas. The CRGA should function as a monitor centre watching over the disaster and also as a command post for relaying the advisories/instructions/orders/requests of the authorities to the various officers engaged in CDMW. Large scale maps and all relevant informations like addresses of various officers/field units operating at the State Capital/District Headquarter Field positions in the cyclone affected areas etc. should be available at the CRGA. The CRGA must in all circumstances keep unbroken telecommunication contacts with the concerned ACWC/CWC and the Flood-Forecasting Organisations in the State.

(Paragraph 2.203)

CRC/116 : As soon as a cyclone threat develops the Chief Engineer (Major Irrigation) should set up a monitoringroom in the Irrigation Department (MRID) at the State Headquarters to keep a close watch on the rainfall and the flood situation that may develop consequent to the cyclone. The MRID should be in unbroken telecommunication contacts with the CRGA, the Flood Forecasting Organisations in the State and the concerned ACWC/CWC.

(Paragraph 2.204)

CRC/117 : District Cyclone Committees (DCCs may be set up at the Headquarters of the districts in the CPARs.

(Paragraph 2.205)

CRC/118 : The composition of the DCCs may be as follows :

Chairman : District Collector
Member : One member may be nominated from each of the following bodies.

A. State Government

1. Agriculture Department
2. Animal Husbandry Department
3. Civil Defence Department
4. Civil Supplys Department: District Supply Officer
5. Fisheries Department
6. Forestry and Rural Development Department
7. Information and Broadcasting Department: District Public Relation Officer
8. Police Department: District Police Superintendent
9. Public Health Department : 1) District Medical and Health Officer, 2) Superintendent, Government General Hospital.
10. Public Health Engineering Department: District Engineer.
11. Public Works Department
12. Refugee Relief Rehabilitation Department.
13. State Electricity Board: District Engineer
14. State Transport Department.

B. Central Government

1. The IMD representative if available in the District
2. Coast Guards Department
3. Defence Establishment in the District Headquarters - Army, Navy and Airforce : from units stationed in the District
4. Post and Telegraph Department

C. Legislature : One member from the State Bidhansabha from the District.

D. Voluntary Organisation -

1. Indian Red Cross Society
2. Representative of other voluntary relief and rehabilitation organisation active in the district.

The office of the District Collector will do the Secretariate work and send out the executive orders of the DCC for Cyclone Distress Mitigation Work (CDMW) via the Cyclone Control Room (CCR).

(Paragraph 2.205)

CRC/119 : The terms of reference of the DCCs should interalia be:

1. To inform the public by organising beating of drums, or sirens or by flares (during night time) or by any other means about the threat of the cyclone.

2. To maintain a Cyclone Control Room (CCR) in the office of the District Collector to organise and correlate all executive actions by him. The CCR would issue to the public and special warnees instructions about precautionary measures to be taken and instructions/orders for evacuation/relief/rehabilitation to the cyclone victims.

3. To mobilise the local resources in manpower and materials like vehicles, powered launches for evacuation/rescue, drinking water, relief as food/clothes/blankets and medicines to combat epidemics of dysentery and cholera etc., and maintain adequate stocks of these materials.

4. To utilise all the resources available locally or through the State Government via the SCYC or from other agencies and organisations and send them for this purpose to wherever they are necessary.

5. To organise evacuation and rescue operations in the areas of Great Danger (AsGD).

6. To set up and run refugee camps till the affected people can be satisfactorily rehabilitated.

7. To organise protection from antisocial criminal elements of property in the (AsGD) from where people have been evacuated.

8. To make immediate assessment of cyclone caused damages in the district and report to Secretary of the Revenue Department.

(Paragraph 2.206)

CRC/120 : The DCCs should meet at least twice a year in April and August just at the start of the premonsoon and postmonsoon cyclone seasons. At these meetings actions taken for preparing the community for cyclones and the success of the CEAP in fighting the cyclones of the immediately preceeding period may be reviewed.

(Paragraph 2.207)

CRC/121 : During a cyclone emergency a DCC in a cyclone affected region should set up a Cyclone Control Room (CCR) which will be in the nature of a monitoring/command post during the emergency. The organisation and the executive responsibilities of the Cyclone Control Room at the District Headquarters should be as follows :

Organisations :

Officer in charge of the Cyclone Control: PA to the District Collector or any other officer nominated by him.

Representatives from various organisations to be stationed at the CCR during a cyclone regime :

1. Police Department
2. P&T Department
3. Public Health Department
4. Public Health Engineering Department
5. Revenue Department: Tehsildars, Huzur Seristadars

Responsibilities :

1. To receive from the SCYC on behalf of the concerned DCC the orders/instructions for dissemination of CAs and evacuation/rescue orders/instructions and advisories about relief/rehabilitation measures for the victims in the cyclone affected regions, fishing boats at sea, and transports on road.

2. To transmit instructions/orders of its DCC regarding the CAs, and the evacuation/rescue/relief/rehabilitatation advisories to various groups of people or organisations in the cyclone affected regions.

3. To monitor continuously during a cyclone the broadcasts of the CWMs by AIR and pass on the informations to its DCC.

4. To establish direct communication with the concerned ACWC/CWC for obtaining the latest information about the cyclone and pass on the information to its DCC.

5. To establish communications with the Police Headquarters for conveying requests from its DCC for evacuation/rescue of cyclone victims from the AsGD.

6. To establish contact with local Defence authorities for any special assistance required by its DCC.

(Paragraph 2.208)

CRC/122 : The District Collector should be given the power to activate the CCR after the first stage 'Cyclone Alert' warning is received by him. Normally the CCR should be deactivated after the cyclone has collapsed and the 'Cyclone Dewarning' signal is received by him. But he should have the discretion to keep the CCR activated in the interest of rescue/relief/rehabilitation of the cyclone victims.

(Paragraph 2.209)

CRC/123 : During cyclone regimes after the 'Cyclone Alert' signal has been upgraded to 'Cyclone Warning' level, the CCRs should work round the clock and the consequent administrative problems should be resolved by the State Government.

(Paragraph 2.210)

CRC/124 : At the taluk level standby Talik Cyclone Committees (TCYCs) may be constituted with members nominated by the District Collector. These would be responsible for carrying out instructions issued by the CCRs of the DCCs.

(Paragraph 2.211)

CRC/125 : At the village level, the Gram Panchayats would be sufficient to supervise the execution of the CAs/instructions/ orders issued via the concerned TCYCs from the CCRs of the concerned DCCs. During cyclone regimes representatives of the P&T department and the local Police should be associated with the Gram Panchayats to help these bodies.

(Paragraph 2.211)

CRC/126 : At the city level the Municipal Authorities should organise, if necessary, emergency cells to meet the threats of an impending cyclone for the executions of the CAs/instructions/orders of the concerned DCC through their CCRs. These bodies should call upon other organisations for help if necessary.

(Paragraph 2.211)

CRC/127 : The SCYC should have joint discussions with the representatives of Ministry of Defence for identifying the equipments which the Defence forces would need to help in a cyclone emergency and also the scale at which they should be distributed to the various administrative echelons within the State Government. Some equipments, which are required for cyclone emergency but can also be put to regular use for their own need by the Defence forces, could be purchased by the State Government and maintained by the Defence forces.

(Paragraph 2.212)

CRC/128 : The DCC should have joint discussions with the representatives of the Defence forces in the district after the cyclone warning has been upgraded, regarding the time and modality of seeking assistance from them. It is necessary that during these meetings, the specific tasks that the Defence Services would be required to undertake in a cyclone emergency, be clearly defined to them.

(Paragraph 2.212)

V.C. TCCs for CDMW

CRC/129 : The CCRs should be equipped with Telephone/ Telex and TP/WT channels and also with transistor radios to monitor the CBs broadcast by the concerned ACWC/CWC over the AIR stations in the State. Messengers on cycles and other vehicles should be put at the disposal of the CCRs.

(Paragraph 2.213)

CRC/130 : On request from the concerned DCC mobile WT stations may be installed by the Police at strategic points in the declared Areas of Great Danger in the local Post Offices where telegram receiving and sending facilities are available.

(Paragraph 2.215)

CRC/131 : It is advisable to appoint a temporary cadre of messengers/peons at the cyclone centres at the taluk/city/village levels, who can take messages/instructions/orders to various places on cycles/motor cycles/other means.

(Paragraph 2.216)

CRC/132 : Each Cyclone Distress Mitigation Centre (CDMCN) at the taluk/city/village level should always have adequate stock of warning equipments : drums, tomtoms, mobile vans with loudspeakers. At various strategic places particularly in the cities sirens should be installed and these should be properly maintained so that they can be used when needed.

(Paragraph 2.216)

V.D. Various stages of CDMW

V.D.(1) Measures to be taken on receipt of the 'Cyclone Alert' signal from the concerned ACWC/CWC - The First Stage

CRC/133 : The coastal State Governments should prepare large scale suitable Cyclone Hazard Potential Maps (CHPMs) area wise based on contour maps referred to under CRC/7 and past experience gathered from the specific areas regarding devastations caused by storms and flood vulnerability and om risk analysis derived from these data. The maps should be made available to the SCYCs and all the DCCs of the coastal States.

(Paragraph 2.218)

CRC/134 : As soon as the 'Cyclone Alert signal is received by the Chief Secretary, a meeting of the SCYC should be called by the Commissioner of Cyclone Rescue Relief and Rehabilitation to discuss interalia the following items :

1. Monitoring the CWMs broadcast by AIR by the CRGA round the clock till 'Cyclone Dewarning' signal is issued by the concerned ACWC/CWC.

2. Alerting the concerned DCCs about the impending cyclone.

3. Taking decisions on plans and strategies to meet the approaching cyclone.

4. The allotment of tasks and responsibilities to various departments of the State Government.

5. The issuance of requests for help to other agencies and departments of the Central Government like AIR, Defence, P&T department, etc.

6. To arrange transmission of CA part of the CBs to the various groups of warnees and designated State Government Officials assigned to CDMW over the communication channels of the State Government.

7. The creation of a cell responsible for drafting and issuance of the CAs.

8. Mobilisation of vehicles, road and water transports like trucks and buses of the State Transport Department, lorries, powered launches, country boats for possible evacuation/rescue operations.

9. Stocking reserve of various relief material - food grains, clothing, medicines for possible distribution amongst cyclone victims and medicines to stop epidemics that may follow in the wake of the cyclone.

10. Establishment of contact with the Flood Forecasting Centres in the State of the CWCM/State Irrigation Department/IMD and the concerned ACWC/CWC of the State for issuance of storm surge/flood advisories. The actual storm surge warnings will be issued by the ACWC/CWC to the SCYC after consultation with the Flood Forecasting Centres.

11. Maintenance by the P&T Department of reliable snap proof TC channels with the ACWC/CWC and the DCCs of the affected areas (via their CCRs).

(Paragraph 2.219)

CRC/135 : On receipt of the 'Cyclone Alert" signal the Commissioner - Cyclone Rescue Relief and Rehabilitation should alert

1. The Irrigation Department
2. The Revenue Department
3. The District Collectors in the threatened areas.

The concerned District Collectors should in turn warn the Municipal authorities, Panchayat Pradhans, Police establishments. Tahsildars in the threatened areas. The Tahsildars should warn the local officers/village committees and start arrangements for activating the public warning system.

(Paragraph 2.220)

CRC/136 : All District Officers who are away on tour should be immediately recalled to District Headquarters to meet the District Collector. It must be seen that no officer is on tour or on leave during the period of the cyclone.

(Paragraph 2.221)

CRC/137 : The monitoring room of the Irrigation Department (MRID) should be activated to watch over the development of the flood situation in the threatened districts. Inspection at close intervals of the state of water levels in the hydrodams, water reservoirs, rivers etc. in the areas marked out in the Cyclone Hazard Potential Maps, should commence at this stage.

(Paragraph 2.221)

CRC/138 : On receipt of the 'Cyclone Alert' signal from the ACWC/CWC, or from the Commissioner - Cyclone Rescue Relief and Rehabilitation of the State Government the first emergency meeting of the DCCs in the threatened districts should be called by the respective District Collectors to work out in advance the strategies to be employed. The DCC in any affected district should be more or less in continuous session when the Warning signal is upgraded there to the second stage 'Cyclone Warning' signal.

(Paragraph 2.221)

CRC/139 : Though the period of 'Cyclone Alert' is the period of little actual danger for people residing on land, it may be the period of the highest danger for fishermen on sea particularly for those who are directly in the path of the cyclone. The CAs therefore contain detailed advisories for sailing, homing and sheltering to nearest identified ports, storing of boats and fishing equipments. The SCYC should directly issue these advisories through AIR broadcasts which should be monitored by the fishermen for taking appropriate safety measure.

(Paragraph 2.222)

CRC/140 : The following items should be on the agenda for discussion/action in the first emergency meeting of the DCCs.

1. Activate their respective CCRs

2. Establish immediate contacts with

   (a) the Police Headquarters and the Thanas in the locality which are threatened by the cyclone, and alert them to standby for establishment of communication with the CCRs.

   (b) the P&T Department requesting them to bring up their communication system upto the talk, block and village levels to a full state of efficiency.

(c) the Defence authorities in the districts and alert them to standby to help the State authorities in possible evacuation/rescue operations.

(d) with the nearest AIR stations directly,

(e) the local fire fighting units, coast guards, civil defence units, irrigation officials, PWD officials, Public Health Officials, Public Health Engineering Officials asking them to be on the alert.

(f the voluntary rescue/relief organisations that generally operate in the State asking them to be on the alert. If there are any lacunae in the communication systems with these bodies then to take immediate steps to remove them or provide alternatives.

3. To study the Cyclone Hazard Potential Map supplied by the State Government obtained from the SCYC/Revenue Department/ Irrigation Department and review of the approach ways to the possible areas of Danger/Great Danger for possible subsequent evacuation and rescue.

4. Identification from the list of shelters : Temples, Mosques, Churches, Municipal High Schools, high grounds, special Cyclone Shelters (CYSHELs), previously selected by the DCC, for mention in the CAs as the recommended gathering points for the refugees and evacuees if the cyclone warning is later upgraded.

5. Identification of Health Centres and assignment of medical workers and provisions of drugs/medicines/vaccines at strategic points in the district for fighting epidemics, that follow in the wake of the cyclones, and planning of removal of affected persons from the scenes of disaster to these centres, and generally providing first aid for minor injuries to men and cattle.

6. Arrangements of messangers and despatch riders on cycles, motor, jeeps, motor bikes, horseback for communication with the officials of the TCYCs, City Municipalities, and Panchayat Offices at the villages to alert them of the impending cyclone.

7. Review the state of the Cyclone Shelters and bring them upto the level of preparedness to receive cyclone victims.

8. Review the state of the equipments at the Cyclone Stores for evacuation/rescue, debris removal, medicines for first aids/epidmics etc. and send requisitions to the appropriate departments of the State Government - Public Works Department, Public Works Engineering Department etc. and AGro Industries Complexes etc.

9. Review the stock of the food grains, dry food commodities, clothing materials and fuels like kerosene and diesel oil etc., that may be available for the cyclone victims, and send the requisitions for any deficit in this respect to the Department of Supplies of the State Government.

10. Assessment of vehicles - lorries, powered, launches, country boats needed for warning/evacuation/rescue for a requsition to be sent to the SCYC and mobilisation of what is available locally and despatching the equipments and vehicles received or commandeered to wherever they are needed. Adequate stock of petrol/diesel oil should be assured for these vehicles and stocked at suitable strategic distribution centres.

11. Detailing all personnel for CDMW to their respective stations.

12. Requesting the PWD to inspect all roads, tanks, bunds, bridges, buildings marked for sheltering evacuees and refugees and to take steps to strengthen and repair them.

13. Requesting the PWD to remove also the dead and dying trees from the road side to prevent them from falling on people during the cyclone regime.

14. Issuance of CAs to local CDMO units at the taluk/city/village levels for warning and bringing them to the public by whatever means that is available.

15. Analyse the preliminary flood risk map received from the Irrigation Department/Flood Forecasting Organisations in the State to take decisions on the necessary steps.

16. Set up a large scale map of the threatened areas in the office of the District Collector for reference/guidance.

(Paragraph 2.223)

CRC/141 : From the time the first meeting is held all communications sent/received from the SCYC, Departments of the State/Central Government, various Agencies/Voluntary Organisations, ACWC/CWC, Flood Forecasting Organisations should be preserved by the DCCs for record.

(Paragraph 2.223)

CRC/142 : The respective CCR should constantly monitor the CWM broadcasts of AIR after the 'Cyclone Alert' signal is received by the DCC.

(Paragraph 2.223)

CRC/143 : On receiving the 'Cyclone Alert' signals the officials in the local CDMO units at the taluk/City/Village level should take immediate measures to warn the people in the threatened areas of the impending cyclone by whatever means that is available - by beating drums/tomtoms, coloured tethered orange coloured baloons/pennants visible from long distances, mobile vans carrying public address systems, sirens etc.

(Paragraph 2.224)

CRC/144 : There are a number of urgent actions that must be taken at the 'Cyclone Alert' stage by the various departments of the State/Central Governments, agencies and voluntary organisations. Some of these steps are listed hereunder :

A. State Government :

1. Agriculture Department : The Director of Agriculture should issue advisories to the farmers in the threatened areas to take precautionary measures to save the crops on the fields and store cut crops and agriculture products on raised platforms or covered sheds.

2. The local CDMO units at the taluk/city/village levels in the threatened areas : These should be in a state of alert and preparedness. In particular they should take prompt actions on the reports of the Municipal authorities/Major Panchayats.

3. Fisheries Department :

(a) The Director-Fisheries will immediately arrange to issue advisories to the fishermen on the threatened coastal regions not to put out to sea and to secure their boats/nets in safe storage places to avoid damage.

(b) The fishermen living at particularly low lying places should be moved to safer places.

(c) Arrangements should be made to give first aid/ medical attention to injured fishermen who return.

4. Irrigation Department :

(a) Flood monitoring room (FMR) should be immediately established in the office of the Superintendent Engineer's office to keep a watch on the local flood situation and feed the information to the MRID at the office of the Chief Engineer (Major Irrigation).

(b) The head regulators of the irrigation system serving threatened coastal areas should be closed and the water allowed to pass through to the river course.

5. The Municipal authorities/Major Panchayats :

(a) They should review the stock of food/clothes from which supplies can be drawn when the actual emergency occurs.

(b) The Municipal authorities/Major Panchayats equipped with public water supply facilities should ensure that the maximum quantity of water is stored in overhead tanks/ water towers. The water tankers with the Municipalities should be brought up to a state of useability and filled up with water.

(c) These authorities should instal emergency diesel sets for generation of electric power for installations needed for maintenance of essential services - pumps for lifting drinking water and removal of flood water, lighting at important units of the CDMOs.

(d) The Panchayat authorities should inspect the Cyclone Shelters (CYSHELs) and bring them up into a stage when they can be used. They should inspect the approach roads to the CYSHELs and report to their local unit of the CDMO.

(e) They should inspect the local health centres/hospitals and the stock of drugs/medicines/vaccines against epidemics and report to the local unit of the CDMO.

(f) They should inspect the stock of various materials/ equipments needed for CDMW : debris removing equipment/ rescue equipments - boats/vehicles/floats/ladders/hooks etc. at the cyclone stores (CYSTORs) and report to the local unit of CDMO.

(g) These authorities should inspect all possible sources of hazards - dying/rotten trees, unsafe building structures etc. and report to the local unit of the CDMO.

(h) These authorities should inspect the state of the orads and bridges in their areas and report to the local unit of the CDMO.

(i) They should inspect the state of water drainage and sewerage in their locality and remove any blocking/choking of the pipes/channels so that they are in a good enough state to carry away flood water. If possible, pump sets should be set up at important points during the emergency for pumping out the water.

6. Police Department

(a) In most states the Police units are equipped with VHF W/T sets (paragraph 2.124). Mobile sets should be set up, if not istalled already, at strategic points for transmitting informations relating to floods and cyclones. As has been stated already this is outside the normal scope of work of the Police Department (Paragraph 2.168, CRC/92) but may be permitted during disaster emergencies. There should be standing orders that the officers of the Revenue Department and various units of the CDMO to use the WT/VHF sets during cyclone emergencies.

(b) During cyclone emergencies mobile vans stationed at important Police Stations should be equipped with VHF sets.

(c) When commandeering jeeps/vehicles, it is also necessary to draft Police drivers and kept on duty for driving the vehicles in case the drivers in the employment of State Government are not found.

(d) The Police Department should insist on the prohibition of passage of all vehicles, as far as necessary, on the roads in the threatened areas to avoid the passengers from being stranded.

7. The Power Department.

(a) The State Electricity Board/various Electric Supply Companies in the threatened areas should make arrangements to disconnect power in the threatened areas. Arrangements should be made to instal generators at important Municipal towns for only very essential purposes. A list should be maintained by the department of the locations from where such generators can be commandeered - cinemas/theatre halls etc.

(b) The Executive Engineer - Power Department in the threatened area should keep himself informed by his counterparts from other districts about the power produced and available for his area and when it is possible to draw this power.

8. The Public Health/Public Health Engineering Department -

(a) The Superintendent, Government General Hospital and the District Medical and Health Officer should keep teams of doctors ready with stocks of medicines/vaccines necessary for relief/prevention of epidemics. The District Medical and Health Officer should prepare a list of Government/Private medical doctors who can be called upon to serve during an emergency created by a cyclone.

(b) The state of the medical stores at the CYSHELs/Cyclone stores/other stores should be inspected by the District Medical and Health Officer and deficit of stock made up for the emergency. He should see that adequate stocks of drugs/medicines/vaccines/vitamins/chemicals for giving medical relief to cyclone victims and to control epidemics is available.

(c) The District Medical and Health Officer should see that adequate number of ambulances are available for relief work and that they are positioned as strategic points from where they can move to the affected areas quickly without loss of time. If sufficient numbers are not available vehicles should be commandeered and put into use as ambulances. Drivers/maintenance technicians for the vehicles/ambulance attendants/paramedical men should be found for these emergency ambulance fleet.

9. The Public Works Department -

(a) The PWD should inspect the weak bunds of all irrigation sources near and around the villages and keep watch over the weak points for taking timely action against any possible breaches.

(b) The PWD should inspect the head gates of the irrigation channels and take necessary repair measures if needed. The Department should inspect the water drainage system and take necessary remedial measures.

(c) The PWD should inspect all public buildings in the threatened areas and take reinforcement/demolition measures as necessary.

10. The State Transport Department

(a) The State Transport buses, private buses and lorries, jeeps, tempoes should be requisitioned, put under the control of this Department and moved to strategic points near the threatened areas.

(b) Sufficient stock of petrol/diessel should be collected at convenient distribution points

(c) Drivers and other support staff should be called in for duty during the emergency for driving the vehicles to the threatened areas for evacuation/rescue work.

(d) When commandeering jeeps/vehicles, it is also necessary to draft Armed Reserved Police drivers and kept on duty for driving them in case the drivers in the employment of State Government are not found.

11. Department of Supplies

(a) The District Supplies Officer should make arrangements for withdrawal of food grains like rice, wheat etc. from the godowns of the Food Corporation of India, State Civil Supplies Corporation and similar organisations.

(b) The Department should maintain a stock of durable eating materials : breads, buns, puffed/pressed rice, chhattu etc.

(c) The District Supplies Officer should obtain sufficient stock of petrol, kerosene, diesel in local distribution centres on Government account and keep them ready for use.

Central Government

1. The Defence Establishment in the State

(a) On being alerted by the DCC the Defence authorities should keep ready of vehicles/amphibians/powered boats that may be needed for evacuation/rescue operations.

(b) All equipments that may be necessary for evacuation/rescue operations in the second phase of the CDMW should be kept ready and available for use.

(c) The Defence authorities should keep ready a number of Helicopters for aerial survey/food dropping/rescue of sick people in the cyclone affected areas if requested.

(d) The communication channels of the Defence establishments in the State should be held ready for CDMW if requested.

2. Port Authorities

(a) Arrangements should be made for safe berthing of ships in the ports. If necessary ships in the ports. If necessary the ships may be directed to move out to the open sea where they may be safer.

(b) The Port Trust Authorities should be given the responsibility of evacuation/rescue work when water transports : powered launches/boats/country boats are needed. All such transports after collection by requisition/commandeering should be put under the disposal of the Port Trust Authorities. Sufficient stocks of petrol/kerosene should be reserved for this purpose.

3. The Post & Telegraphs Departments

(a) The Department should inspect its land based TC Systems that will be used for dissemination of Cyclone Advisories/Bulletins/Informations and bring it up to a level that it can perform these tasks. If possible alternative communication channels in the form of VHF/UHF/microwave links should be provided.

(b) The Department should provide men and materials/equipments at all units of the CDMW for restoring/repairing the communication system as and when needed.

(c) The Department should keep in order the telephones of all officials connected with CDMW.

4. Railways

(a) All the trains on tracks passing through the threatened areas should be brought to a halt at the nearest railway station.

(b) All personnel on duty at the stations located in the threatened areas should be warned to standby.

(c) Arrangements for food/medical attention should be made at all the stations for the period of the cyclone.

(d) The Railway Microwave system should be available to the District Collector during a cyclone emergency if necessary.

(Paragraph 2.225)

V.D.(2): Code of actions to be taken on receipt of the Cyclone Warning signal - The Second Phase

CRC/145 : When the warning is upgraded to 'Cyclone Warning' the SCYC will constantly monitor the actions of the concerned DCCs and keep a watch on their urgent requirements of personel/equipments/materials and supply them at a momemt's notice when requested.

(Paragraph 2.228)

CRC/146 : It is important that the Control Room - General Administration of the concerned State emergency CRGA should now be manned by designated officers of the State Revenue Department, Police Department and Defence Forces.

CRC/147 : In all CDMWs in which the Defence Department is involved, the Department of General Administration of the State Government should take a leading part. The Defence Forces will be assisting the civil authorities in evacuation/rescue operations and running of relief camps. The Department of General Administration will be in overall charge of all this work which involve assistance from the Defence Forces and coordinate these operations.

CRC/148 : When the Cyclone Alert warning has been upgraded to Cyclone Warning the District Collector after discussing the matter at DCC will take the following actions :

1. Declare formally the areas of Great Danger(Land Fall point and neighbourhood), Danger and Alert (ASGD, ASD, ASA). In the ASGD areas must be demarcated and declared to the public as being likely to be submerged and inundated by the inrushing storm surge. These areas would possibly be where evacuations may have to be enforced.

2. Put the Fire Brigade, Police, PWD and Public Health Department, P&T Department and the Defence Forces on alert round the clock during the remaining period of the cyclone regime for carrying out specific tasks at a moment's notice.

3. Stop all transports on roads passing through the ASGD at suitable places or direct them to safer routes if possible.

4. Establish communication systems with the officials working on CDMMs, which are immune to cyclone : Police WT systems or the INSAT DWS system, if that exists in the state. The Superintendent of Police should instal one of the Police WT mobile vans at the CCR of the district for transmitting messages to the affected areas. There should be standing instruction that the staff of the CCR can use on a priority basis any telephone/telephone exchange that is in a working condition.

5. Declare local public holiday for all organisation in the AsGD and AsD. But the officials designated for CDMW and the Departments specially involved in such works do not come under this order.

(Paragraph 2.230)

CRC/149 : On receipt of the 'Cyclone Warning' signal the Superintendent of Police should make arrangements to disseminate the warning through the TCCs of the Police Departments : WT, VHF etc. so that all the Police stations upto the Thana level are alerted. It would be the responsibility of the Officer in charge of a Police Station to transmit the warning to all villages under the jurisdiction of that station.

(Paragraph 2.231)

CRC/150 : The Divisional Engineer, Telephones must communicate the 'Cyclone Warning' message to the various telephone communication hubs in the district. It would be the responsibility of the officer in charge of these communication hubs to transmit the message to Village Officers/Executive Officers/Block Development Officers/ Sarpanch/Panchayat Pradhans etc.

(Paragraph 2.231)

CRC/151 : If all TCCs to the villages fail during a cyclone or if no TCC : telephone, telegram etc. exists upto some group of villages, then the Police Officers in charge of the Thana whose jurisdiction extends over these villages must, after close consultation with the concerned Tahsildars, communicate the 'Cyclone Warning' message through Police Constables/Special Messengers travelling on foot/cycles/motor bikes/horses or by any other means.

(Paragraph 2.231)

CRC/152 : In the final stages of the 'Cyclone Warning' phase, the village Munsiffs or some official of similar ranks should be given the responsibility of delivering the final warning in the AsGD by ringing the bells in temples/churches and public places which should be audible from long distances.

(Paragraph 2.231)

CRC/153 : The Director of Fisheries should direct his staff to spread the 'Cyclone Warning' message to the fishing community together with advisories for fishermen.

(Paragraph 2.231)

CRC/154 : The Cyclone Advisories for AsD must be broadcast very frequently over the AIR. They should be concerned inter alia with the following instructions.

1. People should be requested to monitor with their radio sets, the CB broadcasts of AIR containing the latest warnings of the development/progress of the Cyclone, and also the CAs broadcast locally by the State Government Officials and pass on the informations to others. The listoners should also be instructed that these informations are the most reliable that are available. Thus it is important that the radio receivers in the houses particularly the transistor sets should be fully operational and serviceable.

2. People should be requested to avoid listening to rumours and spreading them.

3. The people must be advised to keep calm and set example to others and help them.

4. Since it is difficult to predict the exact location of the landfall point and the intensity and extent of the storm surge, people should be requested to avoid generally low lying beaches named in the advisories.

5. In regions where there are streams and rivers or river dams, people should be requested to be on alert for dangers offlash floods or dam bursts and avoid possible routes of rushing water released in this manner. Such routes should be clearly named in the CAs by the State Government Officials.

6. If a house is well built and located on high ground in areas likely to be inundated, it is probably the safest place to stay in during the cyclone regime. The public should be so advised and also instructed to stay on the upper floors and avoid the ground floor. But if the authorities advise evacuation from a particular place, then it must be abandoned without question.

7. People should be advised when going outside their residences to avoid trees, dilapidated/old houses and insecure structures and electrical transmission lines. If on road in a vehicle, shelter must be saught at the nearest house without wasting time. In general they should be advised to avoid going outside during a cyclone.

8. The most important thing, every body should be advised about, is examination of the state of the houses they are residing in. If the foundations/roof do not seem strong enough or the general condition of a house seems unsatisfactory it should be abandoned and the residents seek safer shelters.

9. People who stay on in their residences should be requested to board up glass windows or fix storm shutters in place. For this purpose good strong wooden planks should be securely fastened. Make shift and loose boards cause more damage, which fact must be pointed out in the CAs. For doors on outer surface of the houses and buildings strong supports must be provided. If wood planks are not immediately available, paper strips may be pasted on glass panes to prevent splinters.

10. People staying on in their residences should be advised to check loose objects in their houses which may be thrown about by the cyclone wind. Thus loose tiles should be secured by cementing. Doors/windows should be repaired. All articles and goods, which are likely to be blown off, should be tightly secured. In this category are : kerosene tins, cans, agricultureal implements, garden tools, hurricane lamps, burning coals from chulas, road signs and similar objects. These when blown may cause great danger to life and property and should be collected and stored in a room away from the rushing winds.

11. People staying on in their residences should be requested to provide for opening of doors and windows on the lee side of the house i.e. away from the wind.

12. The area round the houses should be checked and dead/lying trees should be removed. Movable objects like lumber piles, loose zinc sheets/bricks, garbage etc. lying outside should be anchored and secured.

13. Children, old people and sick persons and patients from hospitals should be directed to go to identified safer places and the authorities should provide all assistance to them for this purpose. If that is not possible, as much safety should be ensured to them as possible under the conditions. Provisions should be made for special food and medicine that they may need.

14. People staying in their residences should be requested to make provisions for extra food : rice, wheat, flour, grams, potatoes etc. specially of the kind which can be eaten without cooking or with very little preparation : pressed/puffed rice, chhatu, powdered dal etc. Reserve of cooking fuel and drinking water should also be kept to tide over the period of emergency.

15. Hurricanes/lanterns filled with kerosene, extra stock of kerosene and flash lamps with enough dry cells should be kept in reserve in case of power failures.

16. All house holders should be requested to keep reserves of medicines and preventives against epidemics and they should be advised specifically about what items to keep in stock.

17. Valuable goods should be shifted to the upper floors, if these exist, to prevent damage from the flood water. All furnitures, professional/domestic implements, books, valuable clothes etc. should be put in secure places.

18. The public must be informed that after the wind and rain during a storm, a full period may follow, which does not mean that the cyclone is over. It may be the result of the eye of the cyclone passing over the place, in which case there will be another period of wind in the opposite direction, perhaps with greater violence and more rain. So the public must be advised to be watchful and on the alert till the 'Cyclone Rewarning' signal is given.

19. If possible every body must keep contact with the Gram Panchayat Pradhan or the nearest Police Thana and the local Post Office which may have been selected to be local Cyclone Advisory and Operation Centres (CAOOs).

(Paragraph 2.233)

CRC/155 : These CAs like all others will be broadcast by the State Government over its communication channels. The CAs in AsGD must interalia be concerned often with evacuation orders. Thus the advisories must contain the following type of instructions.

1. As soon as an area is declared as an AGD, people residing there should be advised to leave the area sufficiently early before the approaches to the identified high grounds/the cyclone shelters and the relief/refugee camps are flooded and thus avoid being marooned.

2. Identification of place and time of gathering of people of a particular area in an AGD for collection by the Evacuation Authorities. These places should be made known to the concerned people by the personnel at the local CDMW/CAOC centre.

3. In case it is not possible for the Evacuation Authorities to approach immediately a particular locality, advice must be given to the residents of that locality to go to an identified place of comparative safety and wait there for further instruction.

4. As soon as the order for evacuation is issued by the District Collector for a particular declared AGD, people must be advised to lock up their residences and leave. For people hesitating to do so, forcible evacuation by the authorities must be carried out. This may be made known to allconcerned.

5. The domestic cattle should be set free in time and allowed to seek shelters. The animals have a natural instinct to seek out the safest places. This is perhaps the easiest way of saving them from drowning. On no account should they be tethered or tied up at posts or locked up in sheds.

6. Advice must be given about what the evacuees can carry with them including cattles.

7. If upper floors are available, the valuable goods may be removed there before evacuation. Otherwise some possessions, particularly those made of metal can be saved by burying them below ground from where they can be retrieved later, when the storm water has subsided making it possible for the refugees to return. Such instructions may be issued by the District Collector in the CAs.

8. Arrangements should be made for the property of the evacuees to be protected against theft and plunder and the people should be assured of this.

9. Assurance must be given by the District Collector that food, medicine and relief would be provided for the cyclone victims and cattle at the cyclone shelters/refugee camps at all times during and after cyclone emergency.

10. At the evacuee camps at the place of shelters it must be insisted that the instructions of the officers in charge have to be followed. All refugees will be under the camp discipline.

11. It must be insisted that no evacuee may leave the camp unless permitted by the camp commander.

12. People should be advised that they should keep calm at all stages and that the personal dangers would be minimised if the instructions are obeyed promptly.

(Paragraph 2.234)

CRC/156 : Immediately after hearing of evacuation advisory of the State Government, the residents of the notified AGD would take the following actions.

1. Secure their movable valuable properties as best as they can storing in upper floors, burying some underground, if that is possible, and taking similar measures.

2. Let the cattle/poultry/pets loose and let them seek safer places by use of their natural instincts. The cattle should be marked/branded for later identification.

3. Collect and pack the goods/materials that are permitted to be taken by the authorities.

4. If the roads to the identified shelters are open, to proceed immediately with the family towards these destinations.

5. If the roads are cut off by flood water and if boats are available, to make use of them to go to the directed gathering points for collection by the Evacuating Authorities or to the shelters/refugee camps.

6. If the persons are already marooned, then they should make the best safety arrangements as are possible under the circumstances - finding and securing a local shelter, making provisions for emergency food/medicine, trying to arrange distress signals for drawing the attention of the rescue authorities so that they can rush through relief/rescue operations.

7. While at the shelters/refugee camps, the discipline there must be strictly obeyed. No body may leave the camps till permitted by the camp commander.

(Paragraph 2.234)

CRC/157 : Adequate Police arrangements should be made at the Cyclone shelters/relief camps/gathering points to see that the refugees are protected against unruly/antisocial elements.

(Paragraph 2.234)

CRC/158 : The following format may be used for CAs which are to be broadcast by the State Government over their communication channels.

FORMAT 2

Format for the Cyclone Advisory (CA) part of the Cyclone Bulletin

1. Serial Number of the Cyclone: Year X, Month Y, Serial No.Z

2. Authority of issuance of the CA:

3. Serial Number of the Cyclone Advisory:

4. Date/time of issuance of the CA:

5. Description of Area under warning :

Warning Status: Alert/Danger/Great Danger/warning/
Nil warning

Particulars of Warning :

Cyclone Advisory :

(a) Precautions against flying objects
(b) Precautions against storm surges
(c) Precautions against fire
(d) Protection and storing of movable property
(e) Advice about food stock, medicine, fuel for cooking and emergency lights
(f) Evacuation Orders: Including address/location of Cyclone Shelters/Refugee Camps/Gathering Points
(g) Advice about Rescue/Relief/Rehabilitation

6. Nearest Cyclone Advisory and Operation Centre (CAOC) :

Gram Panchayat Office
Local Post Office
Municipality Office
Police Thana

(Paragraph 2.235)

CRC/159 : Though all the facilities provided at permanent Cyclone Shelters can not be provided at the temporary Refugee Camps, the District Collector should ensure the following basic ones :

1. Storage tank for drinking water
2. Emergency diesel generator set
3. Public toilets and water closets
4. Common kitchen and common place of eating
5. Adequate sewerage system immune to storm surge/floods
6. First Aid centre, epidemic fighting centre with public health experts for inspection/advice medical care unit with trained doctors/nurses/attendents.
7. A TC system immune to cyclone like WT system/transistor receivers etc.
8. A team of administrative/technical/medical personnel to care of all problems as they arise. A camp commander must be appointed by the concerned District Collector
9. Some identifying mark - pennants/baloons in life saving orange colour which are visible from a long distance.

(Paragraph 2.236)

CRC/160 : The District Collector after discussing the matter at the DCC will take the following executive actions in AsGD :

1. Move the evacuation and rescue personnel and equipments and vehicles of the State Transport System and other commandered transport vehicles : Cars, lorries, buses, boats, launches etc. to the identified points in the district. If necessary the help of the Defence Forces may be sought at this point.

2. About 12 hrs before anticipated land fall, forcible evacuation of people and cattle from the AsGD - low lands, littoral areas, deltas and estuaries and islands should start taking them to demarcated places of shelter. The agency mainly responsible for this will be the Police, but if necessary, the District Collectors may seek help from the Defence forces for men and equipments.

3. Persons in other areas should be informed in the CAs of their respective shelters and gathering points, health centres and relief distribution centres.

4. The houses and properties abandoned as result of evacuation should be protected against antisocial elements by mobile land and water police as soon as that is possible. Unless public confidence is generated in this matter, evacuation may have to be done only by applying force on reluctant people. The Police Department should therefore be asked by the District Collectors to make all efforts to infuse such confidence in the public. If necessary local reliable persons could be mobilised to help in this operation.

5. The Organisation like the PWD in charge of public buildings should be requested to inspect them and take suitable actions like strengthening them against immediate dangers of collapse as a result of the fury of the cyclone wind/storm surge.

6. The public health workers should be moved to their stations and kept on the alert for rendering first aids to cyclone victims and to implement epidemic preventive measures especially in the AsGD where the problems are the same as those resulting from large scale floods caused by rivers or dam bursts.

(Paragraph 2.237)

CRC/161 : As soon as the warning is upgraded to 'Cyclone Warning' the District Collector should take all steps to maintain essential services as much as possible. The following steps inter alia must be taken by him.

1. Maintenance of power service : During the actual time of passage of cyclone over any area, it may be dangerous to let the cables through high power transmission towers carry electric power. The State Electricity Board should therefore disconnect the supply of electricity to selected areas in AsGD to prevent accidents and injuries. Also there may be urgent need to have electric power in special public places where hospitals, cyclone shelters, relief/refugee camps and evacuation routes are located Generators, already moved into places where they are urgently needed, should be worked by trained technical personnel. The PWD may be the agency for running these generator sets The State Electricity Board and similar metropolitan electricity generating organisation should have a master plan according to which protective switches would be operated to take off power from the High Tension lines and rerouting the electric power along safe guarded High Tension lines with a high priority right of way to important places in a cyclone scene : Cyclone shelters, relief/refugee camps, public health centres/hospitals.

2. Supply of drinking water: If there are over head storage drinking water tank the public water distribution system should be maintained by lifting water to them. It should also be possible to run deep tube wells in the AsGD/AsD through the entire 'Cyclone Warning' period.

3. Supply of minimum food material : At the cyclone shelters, the relief/refugee camps, public health centres/hospitals and for general public consumption, enough stock of rice, wheat, puffed/pressed rice, grams, potatoes, cooking media, etc. should be built up. The rationing system for distribution should be tightened up. The Department of Supplies should assign the highest priority to keeping sufficient reserve of food materials at the stores just outside the AsGD so that these can be transported to the CYSHELs/Refugee Camps/distressed people as soon as possible.

4. Supply of kerosene, diesel oil, storage battery : Enough stock of these materials should be available in the normal distribution system. Stocks should be available at the cyclone shelters, relief/refugee camps and public health centres/hospitals and for transports used for evacuation. The Department of Supplies should ensure that sufficient stock of these materials are available for distribution to all the above centres.

5. Supply of medicine and druges : An adequate supply of the necessary medicines/vaccines/drugs/chemicals for prevention of epidemics should be rushed to the relief/refugee camps/public health centres/hospitals and the stock should be maintained all through the duration of the cyclones and for some time during the post cyclone phase till the camps are disbanded and the refugee return to their homes. Teams of medical men/epidemic experts/paramedical technicians should have by this time moved to their stations at the relief/refugee camps, cyclone shelters, public health centres and hospitals. The Department of Public Health should ensure that these materials are stocked at all the above centres well in advance of the cyclone.

6. Maintenance of the evacuation routes and the essential roads and transports : For purposes of evacuation/rescue the designated escape routes to the gathering points, relief/refugee camps, cyclone shelters, public health centres, hospitals should be kept open and maintained in usuable condition during this phase of the cyclone. The vehicles of the State Transport System and those mobilised from other sources should be maintained in good condition by teams of technical personnel and arrangements made for their garaging and the personnel and found to drive them. The Department of Roads and Transports should be given all this responsibility. In particular the PWD should ensure that these roads together with the bridges en route are in good condition, or take remedial measures if they are not, well in advance of the cyclone. During the 'Cyclone Alert' phase the PWD would be expected to supervise all operations for keeping the roads clear of obstacles fallen trees, rubbles etc. The State Transport should be given the special executive responsibility for moving the refugee to safe places.

7. Vigilance over drainage/sewerage systems and river banks/ irrigation channels/tanks/hydrodams : It would be the joint responsibility of the Irrigation Department and the Public Engineering Department to take all operational measures to prevent floods. The most important measures would be -

(a) To keep the head regulators of the irrigation system serving the AsGD closed and let the water flow down the river course.

(b) The Village Officers/Surpanches/Panchayat Pradhans would be alerted to intensify patrolling of river banks/ irrigation channels/tanks/hydrodams and bring to the notice of the concerned engineers the anticipated locations/ moments of possible breaches of the banks/hydrodams for corrective measures to be taken.

(c) The Public Health Engineering Department should keep constant vigilance over the drainage/sewerage system round the places of habitation to prevent water logging and accumulation of flood water and remove promptly all debris blocking these systems.

(Paragraph 2.238)

CRC/162 : As soon as the warning is upgraded to 'Cyclone Warning' all vehicles moving on the roads through AsGD/AsD should be directed to move and to wait in places of comparative safety, prepared in advance at the direction of the Chief Engineer - Roads and Transport Department.

(Paragraph 2.239)

CRC/163 : When the warning is upgraded to 'Cyclone Warning' the trains passing through the AsGD should be brought to rest at the nearest railway station without any waste of time and berthed there till the warning is downgraded.

(Paragraph 2.240)

CRC/164 : As soon as the trains passing through AsGD have been brought to the nearest railway stations, relief operations should be started by the Railway and Revenue authorities. An enquiry office should be started at these stations with a public address system. Stocks of drinking water, rice, puffed/pressed rice, channa, chapathis, and lemon should be maintained at the stations and milk and biscuits for the children. Medical teams should be posted at the stations. The Station Masters should keep in close contact with appropriate Railway officials the at local/divisional level.

(Paragraph 2.240)

CRC/165 : On receipt of the 'Cyclone Warning' signal the Port Authorities should interalia take the following actions -

1. All vessels should be brought into sheltered waters and marred firmly with the masts lowered down.

2. Some of the bigger vessels, if denied safe berths at the ports due to lack of space, may be advised to move out to demarcated areas on the open sea, if there is time, where they may be safer than in the ports.

3. The general precautionary measures advised for cyclone safe guarding of electrical installations such as sub-stations, baricading of doors/windows/other openings in buildings and securing of movable objects etc., should be immediately put into operation.

4. At the discretion of the Port Master, the electrical power may be cut off during the duration of the second phase of the emergency to avoid casualties from overturned electric poles and exposure to live wires. All transmission towers should have been strengthened during the 'Cyclone Alert' period or earlier.

5. Booms of all cranes and similar machineries should be lowered and put to rest on the ground.

6. All the general cyclone precautionaries recommended to make buildings safe against cyclones should be immediately applied to all godowns/sheds in the port.

7. The appropriate storm signal should be hoisted which should be kept up to date every time new information is received over the CBs broadcast by AIR or from the concerned ACWC/CWC or from the Port Meteorological Office (PMO).

(Paragraph 2.241)

V.D(3) Code of post cyclone measures to be taken after the 'Cyclone Dewarning' signal is broadcast - The Third Phase

CRC/166 : After the cyclone has weakened, the ACWC/CWC should send the 'Cyclone Dewarning' signals to the SCYC, which in turn should relay the message to the concerned DCCs. The concerned CCRs should then issue the 'Cyclone Dewarning' signal to all the units of the CDMO which in turn should transmit the message to officials like Gram Panchayat Pradhans, Chairmen of the City Municipalities, concerned officers of the State Government - Police officers etc., and the concented officers of the Central Government - P&T Officers, Defence units working in the locality etc. This would inform the 'Cyclone Dewarning' message broadcast directly by AIR.

(Paragraph 2.242)

CRC/167 : After the 'Cyclone Dewarning' signal has been issued, the concerned ACWC/CWC should issue a summary of report of the various aspects of the cyclone through the medium of AIR so that the affected population and various groups of warnees are aware of all that has happened.

(Paragraph 2.242)

CRC/168 : Immediately after the receipt of the 'Cyclone Dewarning' signal, the concerned District Collector should start the First stage Cyclone Damage Assessment (CDMA) which must be completed as soon as possible so that Rescue/Relief/Restoration works may start. The main object of this assessment is mainly to -

1. review the state of the TCCs from the CCRs to the units of the CDMW in the affected areas upto the village/city levels that may have been snapped by the cyclone.

2. locate the areas that have been cut off i.e. which can be approached only by boats or after clearance of debris on the roads leading to them, and determine the number of marooned people/cattle in these areas.

3. estimate the number of refugees already in the CYSHELs/ Refugee Camps and quantify their basic needs : food/clothing/ medicine etc.

4. estimate the number/locations of the public utilities put out of operation where restoration is urgently needed for reviving the essential services.

5. examine specially the public health engineering system and assess the locations where epidemic may break out

6. estimate the number and location of dead bodies lying on the roads and other places that have to be removed.

(Paragraph 2.245)

CRC/169 : Since most of the areas where cyclone victims are marooned can not be approached if boats and powered launches are not available in sufficient numbers, the quickest method of locating these areas would be by aerial survey of the affected areas by the planes of the IAF.

(Paragraph 2.245)

CRC/170 : The concerned District Collectors should send to the P&T Department the list of the TCCs in the units of the CDMW in the affected area that are non operational and request the Department for prompt restoration of these channels. They should also make every effort to despatch inspectors to these units to receive the local reports on the TCCs and receive a first hand impression of the damages done by the cyclone.

(Paragraph 2.245)

CRC/171 : The District Collectors of the ravaged areas should set up at their respective CCRs Cyclone Damage Maps for the regions under their respective jurisdictions in order to have a firm basis for planning strategies for Rescue/Restoration works there.

(Paragraph 2.245)

CRC/172 : Immediately after the 'Cyclone Dewarning' signal, the concerned District Collectors should start the First Stage CDMA and get the first reports of the locations of the marooned persons and damages caused by the cyclones. For this purpose assessment teams led by Tahsildars and Deputy Tahsildars should visit the spots indicated by aerial surveys.

(Paragraph 2.245)

CRC/173 : All snapped TCC links - Telephone, Telex, TP etc. should be restored by the P&T Department which should assign to this responsibility the highest priority.

(Paragraph 2.247)

CRC/174 : The District Collector should ensure that immediately after a cyclone all rubbles and debris from collapsed houses and buildings etc. should be removed expeditously in the village/city areas to restore communication. The PWD Department should undertake this work.

(Paragraph 2.248)

CRC/175 : Immediately after a cyclone the District Collectors should ensure that the Roads transport Department take immediate steps to remove the fallen trees. The villagers may be permitted to gather and remove these trees if they can do that quickly so that roads can be cleared without loss of time. For cutting/sectioning these trees local labour/local equipments should be mobilised. The whole work would be done under the direction of the District Collectors who should be given absolute discretion in the matter. Mobile squads and vehicles should be comandeered to carry away these trees.

(Paragraph 2.248)

CRC/176 : The PWD should set up immediately after the cyclone. sqyads of engineers/workers with the necessary equipments/materials to repair the damaged roads and bridges quickly at least on a temporary basis to permit resumption of transport systems by roads. The District Collectors in the affected regions must be informed by the PWD when the roads/bridges have been repaired.

(Paragraph 2.248)

CRC/177 : The District Collectors of the Cyclone ravaged areas should issue suitable warnings to the public against playing with loose dangling electrical wires from electric lamp posts and high voltage transmission towers. The nearest authorities should be informed immediately when their existence is detected. The State Electricity Board/Other Electric Supply Organisation should take immediate steps on receipt the 'Cyclone Dewarning' signal to clear the roads of uprooted electric poles and fallen electricity transmission towers and restore supply of electricity to all consumers as soon as possible. The District Collectors of the concerned areas should be informed of all these actions as soon as they are completed.

(Paragraph 2.249)

CRC/178 : The order of priority of restoration of electric power should be in the following order: (1) AIR, (2) Water Works, (3) Hospitals, (4) All Relief Camps/Cyclone/Cyclone Shelters/Relief Centres (5) Public Health Engineering Works, (6) Railways and Parts (7) Government Offices connected with the CDMW, (8) Private Residences, (9) Agriculture, (10) Commercial concerns - Markets/Stores, (11) Industries, (12) Public Utilities.

(Paragraph 2.249)

CRC/179 : The concerned District Collectors should arrange installation of mobile pumps at strategic places/remote points to drain out the standing water from the fields and roads and places of habitation in the inundated areas, and route it into the drainage channels and river ways immediately after the cyclone has passed.

(Paragraph 2.250)

CRC/180 : Squads formed by the Public Health Engineering Department should inspect all drainage installations in the areas ravaged by the cyclone to see that they are in good working condition. Any necessary repairs and technical problems that may arise therefrom should be solved by this Department so that the standing water can be removed promptly.

(Paragraph 2.250)

CRC/181 : The District Collectors of the ravaged areas should collect informations about all the breaches of the water storage systems in these areas - hydrodams/water resorvoirs/lakes/tanks/bunds etc. which are causing input to the standing water resulting from precipitation caused by the cyclone. Attempts should be made to repair these breaches, at least on a temporary basis, so that essential services can be restored. The concerned District Collectors should request to the PWD to undertake such repairs immediately. The Department of Supplies should provide all the materials necessary for these repairs.

(Paragraph 2.251)

CRC/182 : Permanent repairs of the breaches of the water storage systems in the affected areas may wait till the second stage of Cyclone Damage Assessment has been completed so that an estimate can be made of the budgetary provisions that may be necessary. These repairs can be undertaken at a normal pace in due course.

(Paragraph 2.251)

CRC/183 : The District Collectors of the affected areas should have complete informations about the where abouts of the stranded trains and the schedule of moving them to their destinations.

(Paragraph 2.252)

CRC/184 : The Railway Department should immediately inspect the nature/location of damages to the tracks caused by the cyclone and take prompt steps to repair them.

(Paragraph 2.252)

CRC/185 : The Railway Department should restore normal traffic of passenger/goods trains as soon as possible.

(Paragraph 2.252)

CRC/186 : As long as the Railway Department can not restore the normal running of the trains, it should consider each railway station in the affected area as a Relief Camp and provide all relief to the stranded passengers as is arranged in other Relief centres. It is important to have Public Address Systems installed in each of these stations to inform the public of the latest position about train movements/disseminate relief advisories.

(Paragraph 2.252)

CRC/187 : The Railway Department should make every effort to start the trains moving from where they have been stranded after the tracks have been repaired or by diversions to alternative routes. A senior Railway Officer of the Division should be given the responsibility of taking all decisions about restoration of the Railway service.

(Paragraph 2.252)

CRC/188 : The Railway Department should arrange trains/ waggons for movement of relief materials and cyclone victims to Relief Centres/Cyclone Shelters/Refugee Camps.

(Paragraph 2.252)

CRC/189 : As soon as the cyclone ravaged roads/bridges have been restored, these should be opened to all the normal types of transports : lorries/buses/taxis/private motor cars etc. In particular these roads can be used by the vehicles requisitioned for evacuation/ rescue operations for the marooned persons. Road signs should be prominently displayed to inform the public whether the roads are useful or not.

(Paragraph 2.254)

CRC/190 : The State Authorities should arrange normal trade and commerce to resume as soon as it becomes possible for goods and commodities to move freely by roads/railways/water ways to the normal market places. High priority must be given to bring into the market items like food/fuel/medicines and materials for repair of damaged houses:bamboos/cement/sand/bricks/agricultural seeds/professional tools etc.

(Paragraph 2.255)

CRC/191 : The Police should increase their vigil and patrolling and guard duties to ensure security to life and property of cyclone victims.

(Paragraph 2.256)

CRC/192 : Identified antisocial elements should be rounded up during the period of the cyclone to prevent looting and plundering of property and commission of other crimes.

(Paragraph 2.256)

CRC/193 : The District Collector should organise orderly return to their homes of the cyclone victims, evacuated to Cyclone Shelters/Refugee Camps. For this purpose all help must be given to the refugees, the most important of which is transport. The vehicles of the State Transport Corporation can be put to use in this operation.

(Paragraph 2.257)

CRC/194 : As soon as the areas where the cyclone victims have been marooned have been detected from aerial surveys, the concerned District Collectors should if necessary appeal to the local Defence Authorities for help in rescuing the marooned people.

(Paragraph 2.259)

CRC/195 : The concerned District Collectors should convene a meeting of their DCC after the 'Cyclone Dewarning' signal to discuss and prepare rescue plans. They should also prepare maps showing the location of the Cyclone Shelter/Refugee Camp to which the cyclone victims from a particular zone have to be transported. These Rescue Operation Maps should be put up at the CCRs.

(Paragraph 2.259)

CRC/196 : Rescue teams should be formed promptly after the 'Cyclone Dewarning' signal, from State Government Officials trained in rescue operations and units of the local Defence Organisation/Civil Defence Department/Coast guards. All equipments necessary for rescue operations should be issued from the nearest Cyclone Store by the concerned District Collectors.

(Paragraph 2.259)

CRC/197 : Transport vehicles : Buses/lorries/tempos/ cars/or powered launches/boats/country boats which have been already commandeered should be put at the disposal of the Rescue Teams by the concerned District Collectors as and when demanded. The types of vehicles to be used should depend on the nature of the terrain and the state of distress of the cyclone victims.

(Paragraph 2.259)

CRC/198 : The Department of Irrigation/the Defence Authorities should be able to provide sufficient number of powered launches/amphibian vehicles for Rescue/Relief Operations. Similarly the State Transport Department/Private Transport Organisations should be able to provide the buses/lorries/tempos needed for the same operations. The concerned District Collectors should make use of all these sources to collect the necessary transport vehicles and build up the Rescue/Relief Organisation quickly without loss of time.

(Paragraph 2.259)

CRC/199 : The concerned District Collectors should call upon the local Defence Authorities to arrange aerial dropping of precooked food packets/medicines/chemicals for epidemic control and evacuate by helicopter those who are seriously ill/ injured in areas which can not be reached by the rescue teams. Trained officials of the State Government can be transported by air to these areas to take control of the cyclone victims gathered there.

(Paragraph 2.259)

CRC/200 : The State Authorities should call for help/ direct participation from social welfare organisations and charitable bodies in the relief and rehabilitation work among the cyclone victims necessary after a cyclone and in particular for volunteers to work with the State Government officials.

(Paragraph 2.262)

CRC/201 : If the preliminary assessments of the damages caused by the cyclone appear to be very large, the District Public Relation Officer of the concerned State Government should issue appeals for voluntary donations of money/relief materials and make arrangements to receive them.

(Paragraph 2.262)

CRC/202 : Relief Centres should be established in close proximity of the Cyclone Refugee Camps or at the Cyclone shelters and put under the control of empowered State Government Officers.

(Paragraph 2.263)

CRC/203 : All cyclone relief materials :

1. Stock of food materials : rice grains, wheat, flour dals, various vegetables - potatoes, cauliflowers, cabbages etc., cooking spices/masalas - chillies, tamarind, turmeric powders, cooking media : oils of various types - mustard, coconut, rape seed oil, ground nut oil, cooking fuel : kerosene, coal etc., cooking utensils and other accessories
2. Hurricanes, lanterns, hazzacs with adequate stock of fuels

3. Common medicines and medical treatment accessories

4. General medicines/chemicals for epidemic control

should be stored by the Civil Supplies Department, Food Corporation of India and similar organisations at the Relief Centres for distribution to the various Refugee Camps/Cyshels. For distribution of these materials the lorries should be brought to the Relief Centres for loading and then the destination slips given to their drivers to take the materials to the Refugee Camps/Cyshels and to those villages whose residents need these materials urgently.

(Paragraph 2.263)

CRC/204 : The CCRs of the District Collectors should keep a close watch on the requests for the relief materials and their prompt distribution. It must be seen by the District Collectors that in such procurement/distribution no time is lost.

(Paragraph 2.263)

CRC/205 : Relief Teams will be formed by the concerned District Collectors with State Government Officials and volunteers from Social Service Organisations/Charitable Bodies to carry out the actual Relief Work at the Cyshels/Refugee Camps or at the actual villages ravaged by the cyclone.

(Paragraph 2.263)

CRC/206 : All State Officials/Volunteers from Social Service Organisations/Charitable Bodies, and members of Rescue/ Relief teams should report their activities to the concerned District Collector atleast twice daily and keep the CCRs/Tahsildars informed of their position/movement in the affected areas.

(Paragraph 2.263)

CRC/207 : The concerned District Collectors in collaboration with the Police Department should form squads to remove/ dispose of the dead bodies and carcasses of animals immediately after the 'Cyclone Dewarning' signal before their decomposition sets in. Attempts should be made by Missing Person Enquiry Offices formed by the District Collector with the help of the village officials - Grampanchayat Pradhans and the local surviving people to identify the names of the dead persons before final disposal. Final disposal of dead bodies may pose difficulties and what may have to be ultimately done in mass burial/funeral. The concerned District Collectors should make all arrangements for such disposals - providing of transport for removal of bodies, fuel like coal/kerosene etc.

(Paragraph 2.264)

CRC/208 : The District Medical and Health Officer should send teams with the necessary drugs/vaccines/chemicals to the ravaged villages/Refugee Camps/Cyshels for carrying out a programme of (1) mass vaccination, (2) distributing the necessary palliatives and vitamins, and (3) implementing epidemic control measures specially against spread of cholera/dysentary. At the cities the city municipality authorities should take up this responsibility through their officials.

(Paragraph 2.264)

CRC/209 : Wells and water tanks which may provide drinking water to the people living in the affected regions, particularly in the villages/Refugee Camps/Cyshels, should be treated by the Public Health Engineering Department after the cyclone. These sources with polluted water should be clearly marked out by prominent notices and people warned against using them. A vigorous programme of chlorinisation of the water at these sources, should be undertaken immediately by teams of public health workers under the direction of the District Medical and Health Officer.

(Paragraph 2.264)

CRC/210 : Enquiry offices should be sdt up by the District Collectors for giving informations about dead/injured/missing persons at all centres of CDMW/Cyclone Advisory and Operation Centres (CAOCs)/Cyclone Shelters/Refugee Camps/public places. As soon as the list of these persons can be prepared they should be exhibited at all these places. The work should start with the disposal of the dead bodies and preparation of list of refugees at the Cyclone Shelters/Refugee Camps and finish before the second stage of Cyclone Damage Assessment (CDMA) is started. The assessment of dead/injured/missing persons should be handed over to the second stage CDMA teams for entering into the Cyclone Damage Assessment Form 1 referred to in CRC/212.

(Paragraph 2.265)

CRC/211 : After the refugees are well settled in the Cyclone Shelters/Refugee Camps, the concerned Divisional Revenue Officer should form Cyclone Damage Assessment teams to visit the ravaged areas for assessing the physical/economic damages caused by the cyclone. Each team should include a Gazetted Officer and another Officer not below the rank of Deputy Tahasildar. The assessment should be entered in prescribed forms supplied to the teams and submitted to the Divisional Revenue Officer.

(Paragraph 2.266)

CRC/212 : The Cyclone Damage Assessment Formats cover the total damage caused by cyclones and tropical depressions and associated heavy rainfalls and the storm surges, floods and land slides etc. There should be damage assessments to be recorded in two parts, both following the recommendations of ESCAP :

1. Form 1 : to cover the description of the physical damages in terms of injury and loss of life and cattle, and damage of property caused by wind and water.

2. Form 2 : to cover the damages in various sectors of the economy.

Both forms should be filled up by direct inspection to the extent possible and not from press reports not verified from authoritative sources, or from reports untrained observers.

(Paragraph 2.267)

CRC/213 : The Cyclone Damage Assessment Form 1 (Physical Damage) should have the following format :

FORMAT 3

FORM 1

PHYSICAL DAMAGES CAUSED BY CYCLONE

1. Cyclone Serial number
2. Cyclone Regime - Dates/time
3. Region of Survey :

    Geographic Description

    Number of villages

    Number of towns

4. Date of Survey
5. Sources of information
6. Casualties (Numbers)
    A. Human Lives
        (a) Number of Dead
        (b) Number of Missing
        (c) Number of Injured

Subtotal ______

        (d) People affected
            (i) Number of Families
            (ii) Number of persons

    B. Live Stock :

    Cattle/poultry/pet
        (a) Number of Dead
        (b) Number of Missing
        (c) Number of Injured

Subtotal ______

(d) Domestic animal population affected

Cattle/poultry/pet

7. Crop destruction/damage

Name of crop destroyed

Area with the damaged crop (Hectare.

Total cultivated area with the crop (Hectare)

Estimated damaged crop

Estimated potential yield

Subtotal ______________

8. Loss of trees (in number)

(a) in orchards

(b) Others

Subtotal ______________

9. House and Buildings damaged/ destroyed (number)

A. Huts

(a) Number completely destroyed

(b) Number damaged

Subtotal ______________

B. Residential Buildings

(a) Number completely destroyed or washed away

(b) Number partially destroyed or submerged above plinth level

(c) Number submerged below plinth level

Subtotal ______________

C. Nonresidential buildings

(a) Number completely destroyed or washed away

(b) Number partly destroyed or submerged above plinth level

(c) Number submerged below plinth level

Subtotal ______________

10. Damage to Public Utilities

    Type of utility damaged

    Nature of damage

11. Loss to fishermen

    Boats lost

    Loss of fishing equipments

12. Inundated and/or area with damaged crop/houses (in hectare)

    (a) Cultivated land

    (b) House lots

    (c) Others : Industrial complexes etc.

Subtotal ____________

____

Total ____________

____

13. General Remarks

Signature of Assessment Officer

CRC/214 : The following points should be kept in mind while filling up form 1 of Cyclone Damage Assessment :

1. Casualties should be entered in rows 6A(a), (b) and (c). 'Dead' means confirmed deads or presumed to be dead (row 6A(a)). 'Missing' includes who have not been traced after the cyclone but whose death can not be presumed (row 6A(b)). 'Injured' encompasses all those injured regardless of the seriousness of the injury (6A(c)). Population affected include the homeless, evacuees and in Cyshels/Relief Camps i.e. those qualifying for assistance for relief and rehabilitation as also those whose routine of normal life has been snapped (row 6A(d)).

2. Casualties under rows 6B(a), (b) and (c) similarly include livestock : cattle, poultry and pet animals dead, missing and injured (row 6B).

3. Under row 7 the loss should be recorded under each type of crop : rice, wheat, potatoes etc.. Not only should the areas covering the total cultivated land in the cyclone ravaged area be entered under 7, but also the areas bearing the crops damaged by wind and water must be entered. If possible the estimates should

also be made of the total potential yield of a particular crop in the ravaged area as also of the damaged crop so that it is possible to speak in terms of percentage losses. The area of damaged cultivated lands should be used to estimate monetary value of crop damage by multiplying the area covered by the particular agricultural product direct if estimate can not be made of the damaged crops and the appropriate unit price of the commodity.

4. Loss of fruit bearing trees can be similarly converted (row 8(a) from the number lost into equivalent money value. Loss of other trees should also be recorded to assess the ecological disturbance (row 8(b)). Under row 8(a) would also come things like coconut trees/ palms/casurina trees etc. which dominate the landscape in the coastal regions. Also must be considered fruit trees like mangoe trees/banana plantations/vine yards etc. which are found all along the eastern coast.

5. Huts under 9A will be almost all in the villages Buildings affected (rows 9B and 9C) are classed as 'residential' and 'nonresidential'. Under the classification 'residential' comes private houses, Government buildings, schools, libraries, community centres, places of worship, hospitals, hostels, hotels etc.. Under 'nonresidential' is included storehouses, garages, outhouses etc.. Under row 9(a) B & C those buildings are entered that can not be used any more and must be reconstructed. Row 9(b) A&B should cover those buildings that can be repaired for reuse.

6. Under row 10 will come description of damages to all public utilities - roads/bridges, electricity generation/ transmission systems, hydrodams/bunds/dykes/water reservoirs/irrigation heads, water drainage/sewerage systems, etc.. The physical damages only would be recorded : total destruction, severe damage, light da damage.

7. Under row 11 would come loss of fishing boats/fishing equipments like nets/navigation aids and fishing catches.

8. Under the heading 'inundated and/or area with damaged crops/houses' the most important item is that related to cultivated land (row 12(a)) including paddy fields and those with various crops and house lots, industrial areas and other areas inundated which should be recorded in row 12(b) and (c) for future guidance during reconstruction when land zoning controls may have to be applied. Also valuable guidance can be obtained from this record for predicting storm surges and floods if this data can be correlated with cyclone parameters and rain falls.

(Paragraph 2.269)

CRC/215 : The CDMA Form 2 (Economic Loss) should have the following format.

FORMAT 4

FORM 2

CYCLONE DAMAGE ASSESSMENT OF ECONOMIC LOSSES (IN LAKHS OF RUPEES)

1. Cyclone Serial Number
2. Cyclone Regime : Dates/Time
3. Region of Survey
    Geographic Description
    Number of Villages
    Number of Towns
4. Dates of Survey
5. Sources of Information
6. Loss of livestock
7. Loss of agricultural products/ Loss to Agriculture Department Stores
8. Loss of private property
9. Loss of Government/local/municipal properties
10. Industrial loss
11. Loss of public work facilities : Irrigation/ Electricity/Drainage/Roads/Bridges/Water Storage Systems
12. Loss of public utilities
13. Total loss in Monetory terms

Signature of Assessment Officer

(Paragraph 2.270)

CRC/216 : The items appearing in Form 2 of CDMA must be understood in following terms :

Row 6 : Loss of Live stock : Loss of livestock would include estimates of the price of all cattles/poultry/ pets killed by the cyclone. The estimates may have to be indirectly estimated by judging the loss of cattle etc. by drowning and burial under debris. A direct assessment based on reports from the burviving victims tend to overstress the losses.

Row 7 : Loss of Agricultural Product : This item includes the loss of

1. Rice crops, vegetables, fruits,

2. Marine products,

3. Forest products,

4. Loss due to suspension of agricultural activities

5. Materials stocked in Agriculture Stores - Cut crop/seeds/fertilisers/insecticides/fungicides/agriculture equipments etc.

This group (Row 7) generally constitutes a high proportion of the total flood damage. The crop damage may be estimated by assessing the area under a particular crop damaged and the average loss of that crop per hectare and then summing up the amounts for all the crops. In estimating damage in aerms of money the unit prices of various types of crops have to be considered. Crop damage must be estimated by assessing the extent of damage due to inundation and burial under debris. Loss of livestocks may be similarly estimated.

Row 8 : Loss of property : This includes

1. Houses and buildings,

2. Household articles

3. Stored goods : Tools and equipments of farmers etc.

These should be estimated by surveys and listings. If possible the number of houses and buildings, their floor areas and the extent of damage which must be valued by some established norm of valuation for repair or reconstruction. Household articles include such things as clothes, furnitures, domestic appliances, water pumps, means of transports, books etc.. If percentages can be worked out for damages of household articles then the assessment may become simpler. Damage to stored goods - professional tools and equipments etc. can be similarly estimated.

Row 9 : Loss of Government/local municipal properties : This row should include loss to mining, construction, manufacturing and wholesale, retail and other properties. But loss to industries, agriculture, fishing, transport, communication and other public utilities should be excluded here.

Row 10 : Industrial loss : The industries concerned should be requested to furnish the damages incurred. Indirect damage due to suspension of routine activities may be evaluated by sampling methods. The relevant data in this connection are the number of operational days lost, the number of workers affected, and the value added by industries (per worker per day). However often percentages are assumed for the total loss of general property and industry.

Row 11 : Loss of public work facilities : This includes

1. Agricultural lands

2. Irrigation and Drainage installations

3. Roads and bridges

4. Flood Control installations

5. Harbour, fishing and airport installations

6. Erosion control systems and land slides

7. Streets and roads, urban drainage systems

8. Other public works

All these include all facilities to restore which Government funds would be necessary including restoration of farm lands.

Row 12 : Loss of public utilities : These include inter alia the following facilities :

1. State and private railways

2. Other land, air and water transportation systems

3. Telecommunication Systems

4. Power generation, transmission and distribution systems

5. Water supply systems

6. Gas supply

These mainly consist of organisations operated by the Central Government, State Government or autonomous agencies. Damages should be estimated in terms of building structures (excluding houses), rolling stocks, ships and boats, plants and machineries, and other capital assets and stocked materials and components, including losses incurred through the suspension in full or in part of operations.

CRC/217 : After the Divisional Revenue Officer has collected all the CDMAs from the various areas ravaged by the cyclones, he should prepare a complete Second Stage CDMA report and send it to the Secretary, Revenue Department of the State Government for further processing for the request going from the State Government for financial assistance from the Central Government and advising the State Government about expenditures on financial relief to cyclone victims and the various expenditures on other heads requested at the various stages of the CDMW.

(Paragraph 2.272)

CRC/218 : After the Cyclone, the Commissioner for Cyclone Rescue, Relief and Rehabilitation should prepare a final report on it, containing

1. The success/failure of the Cyclone Monitoring System (CMS) as given by the report of the concerned ACWC/ CWC,
2. The success/failure of the Cyclone Warning System (CWS),
3. The success/failure of the measures encoded in the Cyclone Emergency Action Plan (CEAP) of the concerned State Government as prepared by the Revenue Department,
4. The total assessment of physical/economic damages and loss of life as given by the final report of the Second Stage Cyclone Damage Assessment (CDMA) prepared by the Secretary of the Revenue Department,
5. The total expenditures incurred in carrying through the measures encoded in the CEAP and how the financial problems were resolved as given by the final report of the Secretary of the Revenue Department,
6. The success/failure of the Community Preparedness Plan of the State against the cyclone (CPPC),
7. Plans for Rehabilitation/Reconstruction as prepared by the State Government,
8. Suggestions of remedial measures for any lacunae and for necessary long term measures.

(Paragraph 2.273)

V.E. Financial management of cyclone disaster

CRC/219 : In general the expenditures for applying the CEAP in a coastal State during a cyclone would be very heavy. As the expenditures have to be met by both the State Government and the Central Government, it is necessary that adequate provisions are made by them in their financial outlays for the necessary funds. High priority should be given by both Governments to expenditures on this account.

(Paragraph 2.274)

CRC/220 : The quantum of immediate subsistence financial assistance to cyclone victims should be considered by the Government of India for upward revision to enable them to survive with dignity.

(Paragraph 2.275)

CRC/221 : The losses incurred by the cyclone victims should be classified under three broad heads. Under the first head should come those items for which the victim must make good the loss himself : his personal movable properties/professional tools etc. The State Government may help him in this by giving loans on easy terms of repayment. Under the second head comes those losses which are the fruits of his labour or meant for trade like agricultural products, goods for commerce etc. Much of this can be brought under an appropriate Insurance System. Under the third head comes such items as restoration of residences, restoration of agricultural fields etc.. For the technology of restoration R&D may be necessary and the results should be incorporated in the Community Preparedness Plan against Cyclones (CPPC). The State should undertake these reconstructions and the relocation of sites as a part of its CPPC as the expenses involved may be too much for individual victims.

(Paragraph 2.275)

CRC/222 : The Government of India should encourage the Insurance Companies to cover the areas notorious for being areas of Danger and Great Danger and issue suitable directives to them so that on payment of low premium rates, crops, lands, agricultural tools, live stocks : milch/drought animals and poultry/piggery, dwelling houses, tools and produces of small artisans and small scale industries, fishing equipments of fishermen, goods of small trading and business establishments and even human lives can come under insurance protection. Special arrangements should be made for assessment of damage and quick payments of the insured sums after a disaster.

(Paragraph 2.276)

CRC/223 : The Government of India should set up a National Calamity Fund (NCF) by imposing levies. As soon as possible after the disaster, the cyclone affected State Government should make an assessment of the funds it would need for immediate relief and rehabilitation of the cyclone victims and make a request to the Government of India for liberal release of money from the NCF so that it can make the payment of the required subsidy and loans to the affected population.

(Paragraph 2.278)

CRC/224 : The Government of India should have a scale measuring the severity of a disaster in terms of loss of life/property. Beyond a certain level in this scale (mild disaster) the State Government should be able to meet all the expenditures : Anticipatory/Preparatory, Concurrent, Post disaster, from its own resources. Above this level and below another when the disaster can be termed severe, the present recommendations of the Seventh Finance Commission for Central Assistance should apply unchanged i.e. the shares of the costs would be : Central Government 75%, State Government 25%. If this disaster is more severe the Central Government should bear 100% of the costs which would also include restoration/reinforcement of the facilities/preventives created by the State Government under its Community Preparedness Plan (CPPC).

(Paragraph 2.280)

CRC/225 : Immediately after the occurance of a natural calamity like cyclone, the Government of India can release some funds on an adhoc basis after receiving the report of its Disaster Reconnaissance Team (DRT) visiting the affected State. With this assistance immediate relief to individual victims and restoration activities can be taken up.

(Paragraph 2.281)

CRC/226 : The Disaster Reconnaissance Team (DRT) of the Central Government should consist of technical officers inter alia from the following Ministries/Departments of the Central Government

1. AIR
2. Central Water Commission
3. Central Power Commission
4. Central PWD
5. Post and Telegraph
6. Public Health
7. Public Health Engineering
8. Road and Transport Department
9. Ministry of Agriculture
10. Ministry of Finance
11. Ministry of Inland Waterways
12. Ministry of Shipping

(Paragraph 2.281)

CRC/227 : The DRT should visit the affected State immediately after invitation by its Chief Secretary. It should then have a series of meetings with the SCYC and discuss the Final Second State CDMA Report of damages caused by the cyclone as prepared by the Revenue Department of the State and make its own assessments by on spot inspections and interviews with samples of groups of victims in the AsD and AsGD. This will give the team an objective view of the disaster.

(Paragraph 2.281)

CRC/228 : The final meeting of the DRT and the SCYC would be to consider the question of the ceiling of the legitimate Central Assistances to the affected State and also the quanta of fund allocations under different heads.

(Paragraph 2.281)

CRC/229 : The DRT should submit to the Government of India its final report of the damages caused by the cyclone within three-four weeks after the 'Cyclone Dewarning' signal.

(Paragraph 2.281)

CRC/230 : Through the process of discussion between the DRT and the SCYC outlined in recommendations CRC/225-CRC/229, it is expected that the fears of the Central Government that the damages caused by the disaster have been over/exaggerated, would be dispelled. The report of DTA would assist the Government of India to establish the scale of the disaster and take decision on the quantum of financial assistance which can be given to the concerned State Government.

(Paragraph 2.281)

CRC/231 : A National Finance Corporation for National Calamity (NFCNC) to mitigate disasters may be set up by the Government of India to provide long term loans on easy terms and provide technical help to victims of cyclones and other natural disasters for reconstruction and rehabilitation for resuming t their normal activities, reconstructing their damaged houses, acquiring various inputs for productions and reclaiming lands affected by disaster.

(Paragraph 2.283)

Group B.2 : Recommendations mainly for the Government of India and the coastal State Governments/ with respect to - Community Preparedness Plan against Cyclone (CPPC)

VI. Suggestion for a Community Preparedness Plan against Cyclone (CPPC) for a coastal State

VI.A. The Community Preparedness Plan against cyclones (CPPC)

CRC/232 : The coastal states containing CPARs should include in their Disaster Plans, short and long range measures to prepare the resident communities to face the threats and hazards of cyclones. All these measures should be incorporated into a Community Preparedness Plan against Cyclone (CPPC) for the State.

(Paragraph 2.284)

CRC/233 : The Community Preparedness Measures against cyclones are for the benefit of the individual, the family, various sections of the population, residing in the CPARs of the coastal States, engaged in diverse economic activities - agriculture, fishing, trades and industries etc., and various agencies of the Central and State Governments and those of private nature operating in these areas of the State - Defence, Post & Telegraph, Railways, Shipping etc. The primary basic objectives of these measures are

1. To reduce the risk potential of cyclone damage in the CPARs of the coastal State,
2. To educate the coastal community to respond to cyclones in a disciplined manner.
3. To train the State Administrative Officials to take control of a cyclone emergency by applying the CEAP of the concerned State swiftly without hesitation.

CRC/234 : The long term aspects of the CPPC concerns with

1. Installation of public utilities/facilities/organisations which help to protect the community against cyclones and providing an infrastructure for their maintenance,
2. Spreading the awareness of the hazards of cyclones among the public and educating them about the ways and means of meeting them,
3. Training the workers for CDMW.

The short term aspect of the CPPC is

1. To inspect all the public utilities/facilities/organisations at the beginning of the cyclone seasons every year to ensure that these are in a fit and proper condition to be used efficiently during a cyclone emergency. Any lacunae detected in these systems should be promptly remedied by the appropriate Department of the State/Central Government or the Coastal Development Authority.
2. To supervise and coordinate all repairs/reconstruction work after every cyclone disaster.

CRC/235 : Implementation of the measures suggested in the Community Preparedness Plan (CPPC) against cyclones and the maintenance of the various public utilities/installations set up in the State for it would need large outlay of funds. The State Government should provide for these outlays in their 5 Year Plan Provisions as Plan Schemes and in their annual budgets to carry the schemes through.

VI.B. Coastal Development Authority (CDA)

CRC/236 : Each coastal State should have its Central Development Authority (CDA) to prepare short and long range plans for development of the coastal areas in the State. Measures for reducing the dangers from cyclones for the community should form an important part of the task engaged to this body.

(Paragraph 2.289)

CRC/237 : The management committee of the CDA may have the following composition :

Chairman : To be appointed by the State Government

Members : Members to be nominated one from each of the following Ministries/Departments/Commissions/Authorities of the State/Central Governments.

A. State Government

1. Agriculture and Community Development Department
2. Education Department
3. Finance Department
4. Forest Department
5. Irrigation and Waterways Department
6. Panchayat Department
7. Planning Department
8. Police Department
9. Public Works Department
10. Public Health Engineering Department
11. Revenue Department
12. Roads and Transport Department
13. State Electricity Board

B. Central Government

1. Agriculture Department
2. AIR
3. CPWD
4. Central Water Commission
5. Department of Environment
6. IMD - NHAC (Delhi)
7. Department of Ocean Development
8. Inland Water Ways Authority
9. Land Development Department
10. Ministry of Law - Legislative Department
11. P&T Department
12. Railways
13. Roads and Transport Department
14. Rural Development Department
15. Shipping Ministry

(Paragraph 2.290)

CRC/238 : Among the various tasks and responsibilities of the CDA of the coastal State the following would be relevant for the purpose of preparing the community for cyclones :

1. To establish close contacts with the SCYC for getting acquainted with the problems faced and the experience gained regarding the ravages of each cyclone land-falling in the State and to draw up long range plans for preparing the community against them after detailed risk evaluation by joint consultations.

2. To keep contacts with the ACC for consultation about the preparation of the CPPC of the coastal State.

3. To demarcate areas on the coastal strips where land zoning laws have to be enforced by it.

4. To demarcate areas on the coastal strips for which protection against storm surges may be possible by construction of bunds and be responsible for their constructions and maintenance.

5. To establish forest belts on the coastal strips for protection against cyclones and prevention of soil erosions caused by them.

6. To make arrangements for periodic dredging of rivers in the CPARs of the coastal State.

7. To formulate and implement plans for long term soil and plant conservation in the CPARs.

8. To plan and implement an efficient drainage system in the CPARs to remove the standing flood water.

9. To establish a close network of roads and bridges in the CPARs.

10. To formulate and implement plans for protection of agricultural products against cyclones and storm surges in the CPARs.

11. To lay down a set of building codes in the CPARs and act as consultants in this matter for private owners of house properties. The CDA should enforce the Building Codes for building.

12. To establish permanent cyclone shelters in the CPARs.

13. To plan, instal and maintain an efficient sewerage system in the CPARs.

14. To establish community hospitals at strategic points in the CPARs.

15. To introduce measures for protection of fishermen at sea.

16. To liase with the P&T Department for installation of a snap proof TC system in the CPARs.

17. To prepare a detailed map of facilities/public utilities/installations in the CPARs of the coastal State available for CDMW showing

    (a) Location of the forecasting centres :ACWC/CWC, FFOs of the CWCM/State Irrigation Department/IMD

(b) Locations of various departments of State/ Central Government and various agencies involved in CDMW

(c) Agricultural lands

(d) Location of villages/towns

(e) Beeches

(f) Forest belts

(g) The TC network

(h) The road/bridge network

(i) The Waterways network

(j) The irrigation heads/hydrodams/lakes/water reservoris and bunds/embankments/dykes for flood control, dredging points for rivers

(k) Areas prone to inundation

(l) The drainage system/location of drainage pumps - actual/possible sites

(m) Cyclone Shelters/possible sites for Refugee Camps

(n) Public hospitals, medical centres

(o) Stores of various types for disaster fighting

(p) Sewerage network

(q) Location of electric power houses and the electricity distribution network.

(r) Tracks of Railways running through the CPARs together with the stations

(s) Location of ports of various types, fishing ports, fishing villages

18. To prepare Potential Cyclone hazard maps showing

(a) Possible breakdown of TCCs and alternative channels

(b) Possible areas of submergence under storm surges of a given height travelling in a given direction for a given landfall point

(c) Possible areas of submergence under a given amount/ duration of rainfall

(d) Possible direction of water flow after dam burst/ breach of embankment etc.

(e) Possible areas where evacuation are generally necessary

(f) Possible locations of breakdown of road communications

(Paragraph 2.291)

VI.C. Highlights of a CPPC

CRC/239 : The concerned CDA should examine the topology maps of the coastal strips in its state which were classified as CPARs in Recommendation CRC/6 and demarcate zones where housing/industrial constructions have to be discouraged and controls have to be imposed on the construction of buildings and the pace and type of development activities. Also areas where raising of normal agricultural crops are hazardous should also be marked out. Such areas should be made known to the public with warnings that they come under land use and zoning laws which would be strictly enforced if it becomes necessary.

(Paragraph 2.292)

CRC/240 : The State Governments through their CDAs should enforce punitive measures against violators of land use and zoning laws in the inundable areas in the CPARs such as imposing fines, penalties, demolition measures, high taxation measures etc.. If necessary the State Government may acquire by legislation lands through compulsory sales.

(Paragraph 2.292)

CRC/241 : The great success of the traditional dykes and seawalls in Netherlands should be studied by the CDAs to consider whether similar measures could be introduced in India on an experimental basis at selected sites to save coastal land from the onslaught of storm surges from the sea and prevent the growth of salinity in them.

(Paragraph 2.292)

CRC/242 : The Department of Environment and the Department of Forestry of the Central Government may be consulted by the CDAs for the formulation and implementation of an aforestation programmesin selected coastal areas on an experimental basis with the objective inter alia of breaking the fury of the cyclone winds and storm surges.

(Paragraph 2.292)

CRC/243 : The Department of Environment of the Central Government may be consulted by the CDAs for formulating the long term measures that should be introduced for soil and plant conservation and to prevent large scale coastal erosions that become inevitable under the action of cyclones and storm surges.

(Paragraph 2.292)

CRC/244 : Maps should be prepared by the State Irrigation Departments of the coastal States in consultation with the IMD and River Research Organisations in the State, showing various possibilities of the spatial extents and depths of inundations in vulnerable locations for a given direction of entry of a storm surge, intensity of rainfall, extent of standing water, condition of flooding of nearby rivers and level of water in the hydrodams in the vicinity, local topology and other similar parameters. Model studies can be made by the various River Research Institutes in the State and also at the Central Water and Power Research Station at Pune for specific areas notable for frequent cyclone landfalls and storm surges, and the results of such model studies should be stored in the computers of the ACWC/CWC and the FFOs in the State for ready access/visual display for use as basis for forecasting.

(Paragraph 2.293)

CRC/245 : The CDA should consult the Flood Forecasting Centres of the Central Water Commission/State Government/IMD to map out the path of water from the hydrodams situated near the coastal regions which may have to be released during cyclone regimes to prevent damages to these dams or which may be caused by dam bursts, and also the location/extent of areas which are likely to be inundated as a result.

(Paragraph 2.294)

CRC/246 : The technical officers of the State Irrigation Department should make annual inspection of the flood control facilities before the onset of the monsoon/cyclone seasons and take remedial measures against any failures of these facilities. The inspection should in particular include looking into the state of the flood banks, dykes, embankments, hydrodams etc.

(Paragraph 2.294)

CRC/247 : There should be some research investigations by an appropriate Research Organisation for developing the methods which are best suited to reduce the fury of the incoming storm surges. The CDAs should try out these methods at selected sites on the coast on an experimental basis.

(aragraph 2.294)

CRC/248 : There exist some methods already which break the fury of storm surges - development of anchored inflated rubber tyres, cement cross pieces colosse/vertical piles and other types of obstructions to free flow of water along the be beeches of the coast line. The CDAs should examine the effectiveness of these methods on selected points of the coast generally vulnerable to cyclonic storm surges and in the approaches to selected villages which are repeatedly ravaged by cyclones.

(Paragraph 2.294)

CRC/249 : Since the rivers constitute a natural drainage system which should be able to carry away the greater proportion of the flood water, river beds and river mouths should be annually dredged by the Department of Inland Waterways before the onset of the monsoon/cyclone seasons and kept in a trim condition to drain off efficiently the flood/storm surge discharges and over precipitation of rain.

(Paragraph 2.295)

CRC/250 : The CDAs should plan and establish a network of permanent water drainage channels not only to protect the agricultural fields in the CPARs but also to remove as much of the flood water as possible. These channels should also be maintained by the CDAs in proper condition and should be annually inspected.

(Paragraph 2.295)

CRC/251 : Diesel driven pumps should be installed at strategic points to route the standing water to these drainage channels which would transport it ultimately to the main drainage system constituted by the rivers in the areas or directly to the sea, if that is possible.

(Paragraph 2.295)

CRC/252 : If the CDAs establish their own TC systems, it would be a great help to the DCCs if these channels are made available to them during cyclone emergencies.

(Paragraph 2.296)

CRC/253 : The CDAs should plan a cyclone proof TCC network for cyclone reporting and for CDMW, incorporating systems like two way voice transmission WT systems etc. and in course of time build up such a system with the help of the P&T Department and the IMD.

(Paragraph 2.296)

CRC/254 : It is the responsibility of the Assistant Engineer, District Public Relation Officer and the Block Development Officer to ensure that the Community Radio Sets/ TV receivers are kept in good condition to receive all occasions the CAs and the CWMs. Specific persons should be appointed to listen to these broadcasts at the village level and disseminate the messages to all villagers. The persons to be nominated will be in the category of Sarpanch/Panchayat clerk/Executive Officer/Village Development Officer/Headmaster of the Elementary School or persons of similar ranks/class.

(Paragraph 2.296)

CRC/255 : The CDAs should establish a close net work of roads and bridges, connecting the villages and cities within 20-25 km of the coastal strips.

(Paragraph 2.297)

CRC/256 : The CDAs should develop waterways and landing piers for commuting between the coastal islands and the main land and travelling along the rivers.

(Paragraph 2.297)

CRC/257 : The CDAs should also take the responsibility of maintaining these net work of roads and waterways because their proper functioning is a very important part of any coastal development plan.

(Paragraph 2.297)

CRC/258 : The CDAs should improve the quality of the coastal road network in gradual phases starting with kutcha roads and finally terminating with roads on which lorries and buses can travel.

(Paragraph 2.297)

CRC/259 : The Railway Department may consider raising the railway tracks on artificially raised earth humps or bunds in areas where storm surges usually occur frequently.

(Paragraph 2.297)

CRC/260 : The District Collector should have a list of diesel generators located at various cinema halls, and other places which can be requisitioned during cyclone emergencies. He should also keep a list of priorities for moving the diesel generators to various places where emergency power is needed : Refugee Camps/Cyshels/hospitals/CDMW centres etc. Arrangements must be made to mobilise trained personnel at short notice to operate these generators. A rigid watch should be kept on these generators when put into emergency use, and they should be returned to their owners without fail, when the emergency has passed.

(Paragraph 2.298)

CRC/261 : The State Electricity Board should set up alternative routes for power supply to places/installations with high priority for restoration of electric power when the normal transmission routes have been snapped by the cyclone.

(Paragraph 2.298)

CRC/262 : The CDAs should consult experts on rural housing on the appropriate designs for cyclone and storm surge proof mud houses for the poor regarding effective measures to strengthen the existing ones. While designing such houses techniques should be developed to reinforce the traditional high incline roofs of the mud houses in Andhra Pradesh, Orissa and West Bengal which have shown remarkable success in standing upto the furies of cyclones. Cheap chemical treatment of the mud walls should be developed to stand up against the hammering/ erosion produced by floods/storm surges.

(Paragraph 2.299)

CRC/263 : The Building Research Institute of the CSIR should formulate designs for low cost housings and buildings which can stand upto cyclones and storm surges or which if damaged can be easily repaired and made habitable again.

(Paragraph 2.299)

CRC/264 : The people living in one storied pucca buildings in the CPARs should be advised to keep some bricks and mortar handy, or atleast enough sand bags, to seal up the doors and windows in the ground floor to prevent flood water from entering. If there are upper floors in these pucca buildings it may not be necessary to seal up the ground floors and it may in fact be wiser to keep the doors and windows there open and allow free movement of wind and water.

(Paragraph 2.299)

CRC/265 : The public buildings, for which the ground floors are used for storing purposes, should have arrangements for quick sealing off all points of entry of water at the ground level. Special spurs may be designed on the outside walls of the ground floor to break the violence of the rushing waters. Points of access to these buildings at levels higher than the usual level of storm surges should also be provided.

(Paragraph 2.299)

CRC/266 : The CDAs may consult various consultants, in particular with the Indian Standars Institution, to evolve building codes for industrial complexes in the CPARs to take care of special problems arising for them during cyclone regimes.

(Paragraph 2.299)

CRC/267 : By legislative action, the CDAs should be given the authority/executive power to enforce the Cyclone

Building Code (CBC) in the CPARs of the State with the powers to sanction proposed house/building constructions or demolish existing houses/buildings which are unsafe for human habitation in a cyclone regime or have been constructed in an unauthorised manner or not complying with the CBC.

(Paragraph 2.299)

CRC/268 : The District Collectors and subordinate officers who tour the CPARs should inspect all temples, mosques, churches, schools and college buildings, and public buildings etc. for their suitablility as cyclone shelters. This selection should be done before the cyclone season starts. The location of the Cyclone Refugee Camps/Cyclone Shelters (Cyshels) should be advertised to the public by maps affixed to notice boards in public places, schools, community centres, cinema halls, railway stations, ports, post offices, panchayat offices etc. and also published in newspapers periodically. Special pennants and pennant type baloons in organge should be flown on these shelters so that they can be seen from a long distance.

(Paragraph 2.300)

CRC/269 : In matters connected to construction and use of Cyclone Shelters (CYSHELs) the following points should be kept in view :

I. Objectives and functions of the CYSHEL : It is expected that the coastal population would know well in advance to which CYSHEL they would have to take refuge. The fury of the cyclone would rarely last more than a week, but the storm waters may be expected to stand for a month some times. The units set up for CDMW would be mainly stationed at the CYSHELs and these would be expected to take care of the refugees for a period of a month (phase 3 - postcyclone period) by which time the water would recede and the refugees return to their homes. The medical/epidemic control units stationed here would not only take care of the refugees but also take preventive measures for epidemics in the locality. The relief in goods and money may also be given to the refugees at these shelters.

II. Location :

1. In places where there is acute danger of flooding due to storm surges, the CYSHELs should stand well (at least 3m above) the highest water recorded in the locality.

2. The CYSHELs should be easily approachable during cyclone emergencies by the refugees and the cattle. These should therefore have alternative approach roads so that they are not cut off when some roads become nonpassable due to debris and flood water. The CYSHELs should therefore be situated near the hubs of roadway networks.

3. The sites should be approved by the Collectors after detailed investigation of the environment and neighbouring population, which will use the CYSHELs built on them.

III. Design

1. The CYSHELs may be circular, octagonal or built on rectangular modules.

2. The framed structure should be designed to stand upto a wind speed of 250 kmph and gust winds of 270 kmph in addition to dead and live loads as per National Building Code and should have an infilling of local bricks.

3. It should be a two storied building with a basement. The basement should enclose a fully protected well or bore well of required yield covered with movable inspection covers and space to house pumps/tube wells/diesel generating set/ fuel and storing space for groceries and grains. The ground and first floors should accomodate mainly the dormitories. Sufficient space should be alloted here for Cyclone Relief Administration/Security and Police/Wireless Communication Monitoring Units/Weather Observatory/ Essential Health and First-aid Medical Facilities and an Epidemic Fighting Centre with provisions for a few beds for victims needing medical attention and common kitchen and canteen/public toilet facilities. The water tank should be under the roof level to avoid wind blast, or suitably protected against it.

4. The shelter should have minimum openings. Such windows that must be put in, should be provided with wire meshes on the outer surface and wooden shutters inside. For use of the shelters during the noncyclone season a certain minimum number of windows have to be put in.

5. There should be at least four screen walls integrated to the frame of the main structure so that at any time during a cyclone regime at least one leeward doorway can be left open for late entrants.

6 The roof should have a slight camber at the rim for streamlining and the central area should be sufficiently reinforced to serve as a helipad for delivery of essential commodities and transportation of men by helicopters.

7. The basic design is a two storied RCC building framed structure - for circular designs dimensions 15m diameter and 7m high are capable of taking 500 refugees. But in may areas CYSHELs capable of taking 1000 people may be required.

8. The CYSHELsshould be located on a site of area of about one hectare. A space of 22.5m may be kept

clear round the building to facilitate movement of vehicles for transporting men and materials during cyclone emergencies. Adjacent to the CYSHEL, space for weekly market/shandy (67.5m x 36m), space for cattle, agricultural products, hay etc. (67.5m x 60m) may be provided.

IV. Management and other Units stationed at the CYSHEL : The following units may be stationed at the CYSHELs

1. Office of the CYSHEL Commandant in charge of the CYSHEL and management staff.

2. Security

3. Telecommunication office

4. Weather office

5. Office of the Medical Officer and his staff/ Epidemic Control Centre

6. Office of the Revenue Department for giving relief to the refugees - this should be in the vicinity if not actually in the shelter.

V. Facilities : The following facilities should be provided :

1. Water tank, water pump, tube well

2. Emergency Diesel generator set

3. Public toilets and water closets

4. First aid centre, epidemic fighting centre, medical care unit, a few beds for emergencies with a stock of commonly needed medicines and epidemic preventives

5. Common kitchen and common place for eating

6. Adequate sewerage system immune to storm surges

7. Rescue gadgets like inflatable boats and light bridges, zeeps, ambulance cars etc.

8. Adequate stock of grains, groceries and fuels to last a month

9. Adequate stock of medicines and epidemic preventives for refugees not only sheltering in the CYSHEL but also the residents of the locality.

VI. Special communication channels : The police communication network should be available at the CYSHELs. If the present Police WT/VHF systems are replaced with UHF systems then each CYSHEL should be equipped with an UHF manpack transreceiver.

VII. Use of CYSHEL in noncyclone seasons : It is quite obvious that the CYSHELs should be in continuous community use throughout the year and yet should be available and ready as a cyclone shelter within hours of receipt of the 'Cyclone Alert' signal. Without such continuity of use round the year the shelters would fall into decay and disrepair. The type of use evidently must be such that it can be halted at a short notice and the shelter transformed to be ready for its real use. Thus use as community hospitals, school/college laboratories, libraries must be avoided. However use as class rooms of elementary/high schools, lecture halls in colleges/mahila mandalis/Balawadis/ mangal karyalayas etc. are appropriate community use of CYSHELs.

VIII. Funds for stocks at the CYSHELs and their maintenance :

Adequate funds are necessary to keep the CYSHELs in proper state to receive the refugees at a very short notice. It is therefore necessary for the Commissioner Rescue Relief and Rehabilitation be provided with special funds out of which he may allocate money to appropriate agencies to carry out the required tasks. Without this special funds the CYSHELs would not be able to serve the purpose for which they are built.

IX. Construction Agencies : As most of the CYSHELs would be located at the rural areas, the appropriate construction agency on behalf of government would be the Panchayat Raj Engineering Department, or when there are special reasons, by the Roads and Buildings Departments.

X. Agency for maintenance : In the rural areas the Panchayat Raj Engineering Department would be the proper agency for maintenance of the CYSHELs. Any other Department of the Government may also be given this task if necessary.

(Paragraph 2.302)

CRC/270 : The State Public Health Engineering Department should take the responsibility of establishing an efficient sewerage system in the CPARs, which should be maintained and periodically repaired. A detailed sewerage map of the CPARs should be prepared by this Department.

(Paragraph 2.303)

CRC/271 : The CDAs of a coastal state should have its units for disposal of bodies of victims of cyclones and dead animals which should cooperate with similar units of the concerned State Governments. The CDA should be able to establish common burial/cremation grounds for mass disposal of corpses and dead animals at a short notice.

(Paragraph 2.303)

CRC/272 : The State Public Health Department should have units at permanent health centres with expertise to fight all kinds of epidemics. At these centres arrangements should be quickly set up after the cyclone emergency has passed, to go into operation a mass inoculation programme to prevent outbreak of cholera, dysentry and similar epidemics.

(Paragraph 2.303)

CRC/273 : The CDA of a coastal state should insist on the implementation of the land zoning laws against unrestrained agricultural use of lands in areas liable to be periodically inundated under saline water brought in by storm surges from the sea. These lands may be permitted to be used for raising such agricultural crops which can grow under saline conditions and under prolonged submergence by flood waters. The Indian Agriculture Research Institute (IARI) may be requested to advise on this matter.

(Paragraph 2.304)

CRC/274 : Cut crops which have been already removed from the fields in the low lying inundated areas have to be stored on artificially raised platforms to protect them from storm surges. These platforms should be designed to stand up to the fury of cyclone winds and storm surges. The State Agriculture Department should also provide storing space for cut crops in shed in the rural areas which can stand up to cyclones and storm surges.

(Paragraph 2.304)

CRC/275 : Mobile community driers, perhaps using solar energy should be provided whenever needed in the CPARs for use by the farmers to dry their crops and thereby cut their loss. The appropriate CSIR national laboratory may be requested to develop such low cost mobile driers and the concerned State Agriculture Department may put them to field trials.

(Paragraph 2.304)

CRC/276 : The Department of Environment should be consulted by the CDA of the coastal states regarding measures to desalinate the lands submerged under storm surges from the sea and implement them where necessary.

(Paragraph 2.304)

CRC/277 : The CDA of a coastal state should establish a system of closely spaced fishing ports which need not be very elaborately equipped except that they may have storage space for fishing equipments, boats, some homing signal system and an emergency medical care unit which can be quickly set up during cyclone emergencies. During such emergencies the homing signals should guide the fishing boats to these ports where shelter can be sought and medical care given to injured fishermen. Persons should be trained to manage these ports.

(Paragraph 2.305)

CRC/278 : To facilitate rescue operations, the fishermen should be advised to fit bright orange coloured sails on their boats and generally wear shirts, vests, turbans or scarves in the same colour, which can be seen from a large distance from land air or the sea.

(Paragraph 2.305)

CRC/279 : There should be R&D work on designing fishing boats which may capsize in cyclones but which would not sink easily.

(Paragraph 2.305)

CRC/280 : The State Department of Fisheries should have an arrangement of keeping a master roll of fishermen at sea at any given time and should, in course of time, have their own launches and helicopter to carry out search and rescue operations.

(Paragraph 2.305)

CRC/281 : As a part of the CPPC the State Government should establish stores of various types for materials/equipments needed in a cyclone emergency at strategic points distributed over the CPARs of the State.

(Paragraph 2.306)

CRC/282 : The stock of materials/equipments at these stores should be reviewed annually at the beginning of the cyclone seasons and replenished if necessary.

(Paragraph 2.306)

CRC/283 : One of the first steps to be taken by the District Collectors is to build up the stocks at these stores to the degree necessary as soon as the 'Cyclone Alert' signal is received by them. The materials/equipments have to be requisitioned from different Departments of the State Government/ Central Government and different agencies. At the end of emergency a close accounting should be done of materials/equipments used and the commandeered goods released to their original owners.

(Paragraph 2.306)

CRC/284 : Accumulation of large stock of valuable goods at one place leads to corrupt practicies which should be prevented by strict vigilence by District Collector who should be in administrative control of most types of stores used for cyclone emergencies.

(Paragraph 2.306)

CRC/285 : The location of the stores used in cyclone emergencies should be in close proximity but outside the parts of the CPARs which are notorious for being AsD/AsGD. This would ensure that the stored goods would remain in good condition and not be destroyed by the cyclones, and yet can be moved quickly where required as soon as the emergency conditions have relaxed a little (phase 3 - Post cyclone period).

(Paragraph 2.306)

CRC/286 : Cyclone Stores for evacuation/rescue (ER - CYSTOR) should store the following materials/equipments :

1. Inflatable boats, rubber tyres, life buoys
2. Emergency floating bridges of light structure
3. Grapping hooks, expandable ladders
4. Nylon/jute ropes, wires, chains, spades, crow bars
5. Other life saving equipments
6. First aid kits

CRC/287 : The CYSTORs for relief/rehabilitation (RR-CYSTOR) should be equipped with the following materials which are necessary for setting up emergency Relief Camps or to supply the CYSHELs if required :

1. Tents, tarpaulines, cc sheets, asbestos sheets, polythene sheets which can be used for providing temporary covers
2. Tent pegs, ropes - jute/nylon, steel poles, bamboos, slotted angled iron frames
3. Carpenters tool kits, general all purpose tool kits
4. Buckets, mobile pumps, water tanks
5. Equipments for community kitchen/canteen - large cooking vessels
6. Almirahs/storage bins
7. Emergency lighting equipments, hurricane with kerosene, diesel generators
8. Blankets, clothes, dhotis, saris etc.
9. TC sets - in particular transistor receivers, VHF units, ordinary cycles for messengers.

(Paragraph 2.306)

CRC/288 : Flood Stores (FLOODSTORs) should generally store all equipments necessary for repairs of embankments and breach filling machineries. The machineries for beach filling should include :

1. Proclain, 2. Dozer, 3) Tippers (with rocking bodies), 4. Zeeps with wenches.

(Paragraph 2.306)

CRC/289 : Medical Stores (MEDSTORs) should generally stock general medicines for nervous breakdown, excessive exposure to wind and water, intestinal disorders, vaccines and vitamins. The stock should be furnished by State Public Health Department.

(Paragraph 2.306)

CRC/290 : Epidemic Control Stores (ECSTORs) should generally stock all types of drugs/medicines/chemicals for control of epidemics like cholera/dysentry and remedies for water pollution : chemicals like alum and filtering equipments.

(Paragraph 2.306)

CRC/291 : Agricultural Stores (AGRISTORs) should generally store various types of seeds/agriculture tools/mobile crop driers which can be loaned to the refugees or given as outright grant for rehabilitating them.

(Paragraph 2.306)

CRC/292 : State Transport Department Stores (STDSTORs) As the State Transport Department is expected to play a big role in evacuation/rescue operations, it is advisable to set up a number of garages/workshops/spare spare part depots all grouped under the class STDSTORs at appropriate places in the CPARs. These can be the collecting points of the requisitioned vehicles as well as the places where they can be maintained and repaired during the emergency.

(Paragraph 2.306)

CRC/293 : Since the PWD is expected to play a major role in clearing debris from the roads and knock down damaged buildings which are sources of danger to the public during a cyclone emergency, the Department should set up their stores (PWDSTORs) at appropriate places in the CPARs. These stores should stock equipments like bulldozers/tractors with winching arrangements, perhaps obtained during the emergency from the Agro Industrial Complexes in the State. These stores should also contain sufficient stocks of building materials : bricks/ cement/sand etc. for carrying out expeditiously the programme of restoration of public life. There should be also in these stores sufficient sand bags which can be used to seal up water entry points of important public buildings/utilities.

CRC/294 : Very important from the point of all disasters are the Food Stores (FOODSTORs). The purpose of helping the victims is no doubt served by the various Siloes of the Food Corporation of India and the similar stores of the State Government. But from the point of view of cyclone emergencies the time available to move the food materials to the danger points is very limited. Thus extra FOODSTORs should be set up in the CPARs stocking.

1. Food grains like rice/wheat/dal etc.
2. Precooked/preprocessed food materials like puffed/pressed rice/flour, powdered dal etc.
3. Cooking media like mustard oil/coconut oil/ground nut oil
4. Cooking masalla of various types
5. Simple vegetables like potatoes which can be stored without much trouble over short intervals of time
6. Fuel for cooking : wood/coal/kerosene etc.

(Paragraph 2.306)

CRC/295 : Fodder Stores (FODSTORs) should be established at appropriate places in the CPARs at close intervals. Every year a part of the fodder harvested should be set aside by the State Government and stored in the FODSTORs for use during the cyclone and other emergencies.

(Paragraph 2.306)

CRC/296 : Those commandeered/requisitioned land vehicles for which place can not be found for garaging/parking at the STDSTORs should be parked at other places where permanent structures for these purposes should be provided by the State Government as a part of its CPPC.

(Paragraph 2.307)

CRC/297 : The Irrigation and Waterways Departments of the State Government should set up gathering places along the river sides, at the sea coasts and at the various ports for the commandeered/requisitioned water vehicles. The necessary structures for this purpose should be built by the State Government as a part of its CPPC.

(Paragraph 2.307)

CRC/298 : The CDAs of the different coastal states should establish close liason with the ACC through the concerned SCYCs for generating the legislative measures necessary for preparing the Community against cyclones. The CDAs should be assigned the task of enforcing the laws laid down for all aspects of coastal management/development and given the necessary power/authority.

(Paragraph 2.308)

CRC/299 : The coastal states should build up a pool of officials specially trained in the techniques of cyclone management in all its aspects and other disaster managements, out of which personnel can be drawn and alloted special tasks in a cyclone emergency for mitigating the distress caused. The items and methods of training should be carefully selected and constantly updated in the light of experience gained. The Government of India should come to the assistance of the State Governments in the Disaster Management training programmes.

(Paragraph 2.309)

CRC/300 : The Film Division of the Ministry of Information and Broadcasting should prepare with the help of the IMD, a series of documentaries and video tapes on cyclones, to inform the viewers about the nature of cyclones, their hazards and the devastation they cause, the ways and means to confront them and what to do during cyclone emergencies. These documentaries and video tapes can be shown to the general public just before and during cyclone seasons in cinemas, through Doordarshan and rural community TV circuits of the INSAT. In particular the films and tapes advising the public what they must do in emergencies, should be shown very frequently to viewers in the CPARs. The State Public Relation Department may be given the responsibility of organising the presentation of these visual materials to the public.

(Paragraph 2.310)

CRC/301 : The AIR should arrange frequent broadcasts of suitable programmes about cyclones - their nature, their hazards and the devastations they cause, how to confront them, and what should the people do during cyclone emergencies. These broadcasts should be arranged just before and frequently during the cyclone seasons taking special care that they are directed to listeners in the CPARs. The broadcasts can be included in the school broadcast programmes and in community programmes directed to rural listeners.

(Paragraph 2.310)

CRC/302 : The State Public Relation Department may seek the help of the local newspaper media to inform the public about cyclones, their origin and nature their hazards and the devastations they cause, how to fight them and in emergencies what to do. This should be done through articles written by experts of the IMD, which should appear frequently in the newspaper during cyclone seasons particularly in those circulating in the CPARs.

(Paragraph 2.310)

CRC/303 : The State Public Relation Department should circulate booklets/pamphlets on cyclones in the rural areas in the CPARs through the gram panchayats. These booklets should contain specific informations for the rural population how to meet cyclones and in particular what to do during cyclone emergencies. The booklets may be prepared with the help of the IMD. They should be in local languages and should be available at nominal prices from government stationery shops, book shops, Railway stations and prominent places where people assemble.

(Paragraph 2.310)

CRC/304 : The CDAs should prepare cheap pamphlets for circulation among the public in the CPARs containing advisories and codes of constructing cyclone proof huts/buildings.

(Paragraph 2.310)

CRC/305 : The IMD should establish a publicity cell in each ACWC/CWC which will work in collaboration with the news media, AIR, Doordarshan, and the State Publicity Department to educate the public of the CPARs about cyclones - their nature, hazards, measures for community preparedness, and instructions required to be followed in emergencies.

(Paragraph 2.310)

CRC/306 : The Directors of Public Instruction (DPIs) in the coastal States should ensure that the syllebi of Indian schools at the secondary level include the subject of cyclones in very elementary and descriptive terms with informations about some famous Indian cyclones and also regarding what to do during cyclone emergencies as has been done in Burman, Phillipines and other countries. The National Council of Educational Research and Training (NCERT) should arrange the publication of suitable text books for the schools to cover these topics.

(Paragraph 2.311)

CRC/307 : Frequent seminars should be arranged by the State Government in collaboration with the IMD and other agencies at schools on subjects covering the causes of natural disasters, their prevention, mitigation of distress caused by them to people including measures for relief rehabilitation reconstruction and restoration of normal life. State Officers in charge of relief and other experts should be invited to give talks on these subjects at these seminars.

(Paragraph 2.311)

CRC/308 : To generate interest in cyclones, Cyclone Clubs should be formed in the coastal States. An important activity at the Cyclone Clubs should be to monitor the CWM broadcasts over the AIR, and to keep records of tracks, movements and other parameters of various cyclones like wind speeds and pressure depths and also of various other informations like the extent and categorisation of damages caused by them in these states. These clubs should also arrange group discussions on the cyclone problem. In times of cyclone emergencies they can contribute directly by volunteering in cyclone distress mitigation operations. The work of these Clubs would help to a very great extent to spread the awareness of the cyclone problem among the general public.

(Paragraph 2.312)

CRC/309 : The recommendations of the State CDMCs should be reviewed specially with respect to CEAPs of these states and their CPPCs in the light of subsequent experience gained of cyclone disasters and the recommendation made by the Cyclone Review Committee. While formulating the CEAPs the established administrative practices prevalent in the concerned state should be kept in view.

(Paragraph 2.313)

Group C : Recommendations for Research and Training

VII. Cyclone Research and Training

CRC/310 : It is important to organise continuous research on Indian cyclones to improve the forecasting capabilities and methods of detecting and tracking them.

(Paragraph 2.314)

CRC/311 : The Cyclone Warning Research Centre at Madras should be expanded into a National Cyclone Research Centre which should be responsible not only for research on Indian cyclones but also for development/assessment of forecasting techniques.

(Paragraph 2.314)

CRC/312 : There is need for the Indian Universities, Indian Institutes of Technology and various research agencies in India to organise research projects on tropical cyclones.

(Paragraph 2.315)

CRC/313 : There should be well supported research projects on cyclone caused storm surges, their origin and their identification of various parameters determining their origin nature and effects. This may be organised by the IMD in collaboration with the Department of Oceanography.

(Paragraph 2.316)

CRC/314 : Model studies on the rivers in the CPARs should be undertaken by the IMD in collaboration with the Central Water Research Station at Pune, to understand the interaction of the state of these rivers with the storm surges, and to devise techniques for forecasting the extent of inundations caused by rainfall, wind action and storm surges induced by cyclones in various sectors of the CPARs, taking into consideration the state of the rivers and other conditions there during cyclone regimes.

(Paragraph 2.316)

CRC/315 : A national multidisciplinary and multi-institutional project may be initiated by the DST for aircraft probing of cyclones/other weather disturbances like thunderstorms/norwesters. The aircrafts can be used also to monitor and study the behaviour of clouds and monsoons.

(Paragraph 2.318)

CRC/316 : A team of experts may be sent to visit countries like USA/Japan where the technique of probing by aircraft has reached a high level of perfection with the objective to find out the economic viability, aspects of training/operations and the potential for research in this technique.

(Paragraph 2.318)

CRC/317 : For successfully operating the Cyclone Plan suggested by the Committee, quite a large number of specialists should be trained abroad and in this country in cyclone forecasting/warning work, techniques of interpretation of data obtained by different techniques of cyclone observations, who would in turn in course of time, generate a band of competent meteorologists needed in the Cyclone Plan.

(Paragraph 2.320)

सत्यमेव जयते

ERRATA

PARAGRAPH 2.349 TO 2.351 WHICH CONTAIN THE INFORMATION OF P&T COAXIAL LINKS HAVE BEEN UPDATED AND ARE REPRODUCED IN THESE FOLLOWING SHEETS.

Table 2.55

P & T Coaxial Links as on June 1982 in the coastal States of India

Legend : WB = Wide Band, NB = Narrow Band, A = Analogue, D = Digital
Categories : I = Existing, II = under execution/planned

Link	Status
A. Circuits near the coast	
1. Calcutta-Kharagpur-Balasore-Bhadrak-Cuttack Bhubaneswar-Behrampur/Ganjam-Srikakulam-Vijayanagram-Visakhapatnam-Tuni-Rajmundry	One A/WB/I One A/WB/II
2. Rajamundry-Elluru-Vijawada	One A/WB/I
3. Rajamundry-Ravalapalayam-Tanaku-Tadipalligudem	One A/NB/I One A/WB/II
3A. Tadipalligudem-Gudiwada	One A/WB/II
4. Ravalapalayem-Amalapuram	
5. Ravalapalayem-Nandapeta	One A/NB/II
6. Rajamundry-Samalkot-Kakinada	One A/NB/I
7. Vijawada-Guntur-Ongole-Nellore-Guddur-Madras	One A/WB/I One A/WB/II
8. Vijawada-Kodad-Suryapet-Secunderabad	One A/WB/I One A/WB/II
9. Kodad-Khammam	One A/NB/I
10. Madras-Pondicherry-Cuddalore-Mayuram-Khumbhakkonam-Tanjavur	One A/WB/I
11. Madras-Villupuram-Tiruchirapalli	One A/WB/I

Link	Status
12. Tirruchirapalli-Tanjavur-Thiruvarur-Managudi-Nagupattinam	One A/NB/I
13. Tiruchirapalli-Karur-Coimbatore	One A/WB/I
14. Tiruchirapalli-Dindigul-Madurai-Virudhunagar-Tirunelvelli	One A/WB/I
15. Tirunelvelli-Tuticorin	One A/NB/I
16. Tirunelvelli-Ambasundaram	One A/NB/I
17. Ambasundaram-Tenkasi-Sankaracoil	One A/NB/II
18. Tirunelvelli-Nagarcoil-Trivandrum-Quillon-Kottyam-Ernakulam-Alwaye	One A/WB/I
19. Alwaye-Perumbavoor-Kothamangalam-Muratnupuzha-Thedupuzha	One A/NB/II
20. Alwaye-Trichur-Kunankulad-Ponani-Tirur-Kozhikode	One A/NB/I
21. Alwaye-Palghat	One A/WB/I
22. Palghat-Coimbator	One A/WB/I
23. Palaghat-Ottapalam-Perintalman-Malapuram-Manjeri-Kozhikode	One A/WB/I
24. Cannanore-Poyganur-Kankangode-Kasargode-Mangalore	One A/NB/II
25. Madras-Vellore	One A/WB/I
26. Vellore-Chittoor	One A/NB/II
27. Vellore-Bangalore	One A/WB/I
28. Vellore-Krishnagiri	One A/WB/II
29. Vellore-Arni-Tirunelmallai	One A/NB/I
30. Krishnagiri-Bangalore	One A/WB/I
31. Bangalore-Davangire-Hubli-Belgaum-Kolhapur	Two A/WB/I
32. Kolhapur-Pune	One A/WB/I
33. Kolhapur-Korad-Satara-Pune	One A/WB/I
34. Pune-Cinch-Thana	One A/WB/I One A/WB/II
35 Thana-Bombay	One A/WB/I
36. Thana-Panvel	One A/NB/II
37. Thana-Bulsar-Surat-Baroda	One A/WB/I
38. Baroda-Anand	One A/NB/II
39. Baroda-Ahmedabad	One A/WB/I
40. Ahmedabad-Surendranagar-Rajkot	One A/WB/I One D/WB/II

	Link	Status
41.	Rajkot-Gondal-Jaitapur-Dhoraji	One A/NB/I
42.	Dhoraji-Upleta-Porbandar	One A/NB/I
43.	Dhoraji-Junagarh-Kishod-Veraval	One A/NB/I
B.	Inland routes connecting coastal cities among each other and With Delhi	
44.	Delhi-Mathura-Agra-Kanpur	One A/WB/I
45.	Delhi-Hapur	One A/WB/I
46.	Delhi-Meerut-Hapur	One A/WB/I
47.	Hapur-Bareilly-Shahjanpur-Sitapur-Lucknow	One A/WB/I One A/WB/II
48.	Kanpur-Lucknow	One A/WB/I One A/NB/I
49.	Kanpur-Allahabad	One A/WB/I
50.	Lucknow-Rai Bareilly-Mirzapur-Allahabad	One A/WB/I
51.	Allahabad-Varanasi	One A/WB/I One A/WB/II
52.	Varanasi-Sasaram	One A/WB/I
53.	Sasaram-Patna	One A/WB/I
54.	Varanasi-Buxur-Patna	One A/WB/II
55.	Sasaram-Asansol-Ranigunje	One A/WB/I
56.	Ranigunje-Burdwan-Calcutta	One A/WB/II
57.	Patna-Calcutta	One A/WB/II
58.	Agra-Jaipur	One A/WB/I
59.	Jaipur-Ajmer-Beawar-Udaipur-Himmatnagar-Ahmedabad	One A/WB/I One A/WB/II
60.	Agra-Gwalior-Jhansi-Lalitpur-Sagar-Damoh-Jabalpur-Seono-Nagpur	One A/WB/II
61.	Nagpur-Amraoli-Akoli-Bhuswal-Jalgaon-Dhulia	One A/WB/I
62.	Dhulia-Manmad-Nasik-Thana	One A/WB/I
63.	Dhulia-Aurangabad-Ahmednagar-Wada-Pune	One A/WB/I One A/WB/II
64.	Nagpur-Wardah-Pondarkwada-Adilabad-Nirmal-Nizamabad-Komareddy-Secunderabad	One A/WB/I
65.	Secunderabad-Mahaboobnagar-Kurnool-Guntakal-Anantapur-Hindupur-Bangalore	One A/WB/I

2.350 P & T UHF network in coastal states of India upto 31.10.1982[1] :

Table 2.56 gives the UHF network in the coastal states commissioned upto December 1982 as also those under execution or being planned

Table 2.56

P&T UHF network in coastal states of India upto 31.10.1982

Legend : Category : I = Commissioned, II = Under Execution,
III = Planned

Link	Status
1. Calcutta-Haldia	I
2. Diamond Harbour-Kulpi	III
3. Midnapore-Kharagpur	II
4. Baripada-Balasore	II
5. Keonjhar-Jejepore	III
6. Cuttack-Paradeep	I
7. Phulbani-Berhampur (Ganjam)	III
8. Kakinada-Yanam	III
9. Tenali-Bapalta	II
10. Sattanpalle-Guntur	III
11. Guntur-Narasaropet	II
12. Shriharikota-Madras	I
13. Madras-Kanchipuram	II
14. Cuddalore-Neyveli	II
15. Thanjavur-Puttukottai	II
16. Tirichirapalli-Pudukotai	I
17. Madurai-Parmakudi	II
18. Permakudi-Ramanathpuram	I
19. Mandapam-Rameshwaram-Nahar (Shrilanka)	I
20. Rajapalayam-Virudhanagar-Sivkashi	I
21. Quillon-Punnalur	II

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[1] Information provided by Shri R. Lalwani, Director (MR) P & T Department

Link	Status
22. Kottayam-Nanjirapalli	III
23. Kottayam-Peermedi	III
24. Kottayam-Palai	I
25. Shertalai-Allepy	II
26. Ernakulam-Idukiki-Munnar	II
27. Trichur-Kunamkulam	I
28. Kozhikode(Calicut)-Manjiri	I
29. Kozhikode-Kalpeta	I
30. Kozhikode-Badagra	I
31. Mangalore-Puttur	I
32. Mangalore-Bantwal	II
33. Mangalore-Baleswara	I
34. Mangalore-Udipi	I
35. Targad-Sirsi	II
36. Panjim-Karwar	I
37. Panjim-Ponda	II
38. Panjim-Mapuga	II
39. Panjim-Vasco-Murmagon	I
40. Ratnagiri-Hathikhamba	II
41. Bombay-Alibagh	II
42. Bombay - Pen	II
43. Bombay Twin City	I
44. Bombay-Butcher Island	III
45. Bulsar-Silwasa	III
46. Bulsar-Ahwa	III
47. Baroda-Dopahi	III
48. Ahmedabad-Nadiad	I
49. Nadiad-Kapadwand	II
50. Ahmedabad-Talod	II
51. Ahmedabad-Bhavnagar-Savarykundla	I
52. Bhavnagar-Botad	III
53. Savarykundla-Amerli-Junagadh	III
54. Bhavnagar-Mahuva	II
55. Okha-Dwarka-Khambaliya	II
56. Morvi-Rajkot-Wankaner	II
57. Surendranagar-Dhargondhra	II

2.351 P & T Microwave network in coastal states of India :

Table 2.57 gives the Microwave network in the coastal states (wide and narrow bands in analogue/digital modes) completed, under execution and being planned.

Table 2.57

P & T Microwave Network in the coastal states of India[1]

Legend : WB = Wide Band, NB = Narrow Band, A = Analogue
D = Digital
Categories : I = Completed, II = Under Execution,
III = Planned

Link	Status
A. Circuits near the coast	
1. Calcutta-Uluberia-Haldia	One A/NB/III
2. Calcutta-Kharagpur	Two A/WB/I
3. Kharagpur-Cuttack	One A/WB/II
4. Cuttack-Dhenkanal	One A/NB/II
5. Cuttack-Sambalpur	One A/WB/II
6. Cuttack-Bhubaneswar	One A/WB/III One A/NB/I
7. Cuttack-Berhampur-Srikakulum-Visakhapatnam-Rajamundry (Kotabommuru)-Vijayawada	One A/WB/II
8. Bhimabharam-Tadepalligudem-Palakoli	One A/NB/I
9. Vijayawada-Secunderabad	One D/WB/III
10. Vijayawada-Nellore-Madras	One A/WB/II
11. Vijayawada-Tennali-Guntur	One A/NB/I
12. Guntur-Narasropet	One A/NB/III
13. Guntur-Chilakularipet-Satenapalli	One A/NB/III
14. Guntur-Ponnura-Bapatla	One A/NB/III
15. Bapatla-Chirala	One A/WB/III
16. Madras-Tirupathi	One A/NB/I
17. Madras-Guntakal	One A/WB/III
18. Madras-Bangalore	One A/WB/I
19. Madras-Kanchipuram	One A/NB/III
20. Madras-Salem-Tirruchirapalli-Madurai-Rameswaram-Colombo(Shri Lanka)	One A/WB/I

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[1] Information provided by Shri R. Lalwani, Director (MR) P & T Department

Link	Status
21. Salem-Coimbatore	One A/WB/II
22. Madurai-Kodaikanal	One A/NB/I One A/WB/III
23. Madurai-Virudhnagar	One A/WB/II
24. Madurai-Karaikudi	One A/NB/III
25. Virudhnagar-Siriviluputur	One A/NB/III
26. Virundhnagar-Sivakasi	One A/NB/II One A/WB/III
27. Sivakasi-Tirunelvelli-Trivandrum	One A/WB/III
28. Trivandrum-Allepy-Ernakulum-Kozhikode-Mercara-Mangalore-Panjim	One A/WB/I
29. Kodaikanal-Theni	One A/NB/II
30. Allepy-Kottyam	One A/NB/II One A/WB/III
31. Ernakulum-Alwaye	One A/NB/II
32. Ernakulum-Polachi-Coimbatore	One A/WB/II
33. Ernakulum-Irinjalakuda	One A/NB/II
34. Trichur-Konnamkumbal	One A/NB/II
35. Coimbatore-Kodaikanal	One A/NB/I One A/WB/III
36. Coimbatore-Octacamund-Mysore	One A/WB/III
37. Coimbatore-Coonoor-Kozhikode	One A/NB/I
38. Coimbatore-Kozhikode	One A/WB/III
39. Octacamund-Coonoor	One A/NB/I
40. Kozhikode-Tellicherry-Cannanore	One A/NB/I One A/WB/III
41. Mangalore-Udipi-Coondapur	One A/NB/II
42. Panjim-Vasco-Marmagaon	One A/NB/II
43. Marmagaon-Karwar	One A/WB/III
44. Panjum-Belgaon	One A/NB/II One A/WB/III
45. Panjim-Bombay	One A/WB/I
46. Pune-Ratnagiri	One A/NB/I
47. Bombay-Pune	One A/WB/II
48. Bombay-New Bombay	One A/NB/I
49. Bombay-Thana	One /WB/I
50. Bombay-Surat	One /WB/III

Link	Status
51. Surat-Baroda-Ahmedabad	One A/WB/III
52. Surat-Broach-Bhavnagar	One A/WB/II
53. Ahmedabad-Kaira-Cambay	One A/WB/II
54. Ahmedabad-Nadiad	One A/WB/II
55. Nadiad-Godra	One A/NB/II
56. Ahmedabad-Bhavnagar	One A/WB/II
57. Bhavnagar-Mahuva	One A/NB/III
58. Bhavnagar-Amreli-Rajkot	One A/WB/II
59. Rajkot-Jamnagar	One A/NB/I
60. Jamnagar-Khambala	One A/NB/II
61. Jamnagar-Kandla-Bhuj	One D/NB/I
62. Surendranagar-Dhargandhra	One A/NB/II
63. Junagadh-Manvadar	One A/NB/II

B. Inland routes connecting coastal cities among each other and with Delhi

64. Ahmedabad-Bhalwara-Jaipur	One A/WB/III
65. Jaipur-Alwar-Delhi	One A/WB/I
66. Alwar-Rewari-Delhi	One A/NB/I
67. Delhi-Agra	One A/WB/I
68. Agra-Kanpur	One A/WB/I
69. Delhi-Bareilly-Lucknow	One A/WB/III
70. Kanpur-Lucknow	One A/WB/I
71. Lucknow-Gorakhpur-Patna	One A/WB/I
72. Kanpur-Allahabad	One A/WB/I
73. Allahabad-Jabalpur	One A/WB/I
74. Allahabad-Varanasi-Arrah-Patna	One A/WB/II
75. Patna-Asansol	One A/WB/I
76. Patna-Katihar-Malda-Phulian-Berhampur-Krishnanagar-Ranaghat-Calcutta	One A/WB/I
77. Asansol-Kharagpur	One A/WB/I
78. Asansol-Calcutta	One A/WB/I
79. Patna-Gaya-Hazaribagh-Ranchi-Jamshedpur	One A/WB/II
80. Kharagpur-Jamshedpur-Sambalpur-Nagpur	One A/WB/I
81. Nagpur-Jabalpur-Sagar-Thana-Gwalior-Agra	One A/WB/I

Link	Status
82. Sagar-Indore-Kotah-Jaipur	One A/WB/I
83. Indore-Ratlam-Ahmedabad	One A/WB/I
84. Indore-Dhulia-Thana	One A/WB/I
85. Dhulia-Nagpur	One A/WB/I
86. Nagpur-Chanda (Chandrapur)-Nizamabad-Secunderabad	One A/WB/II
87. Pune-Sholapur-Secunderabad	One A/WB/I
88. Secunderabad-Raichur-Guntakal	One A/WB/II
89. Guntakal-Belgaon	One A/WB/III
90. Guntakal-Bangalore	One A/WB/II
91. Mysore-Bangalore-Morcara	One A/WB/I

सत्यमेव जयते